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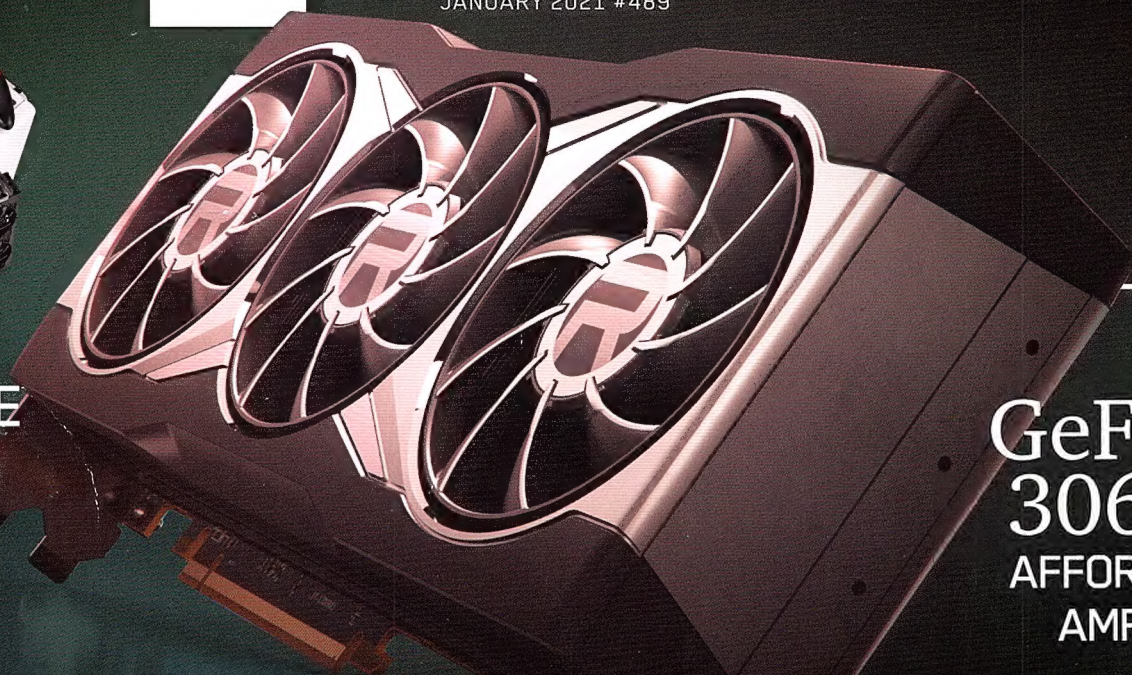
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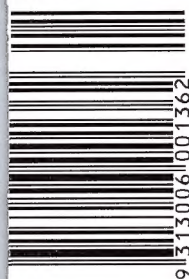
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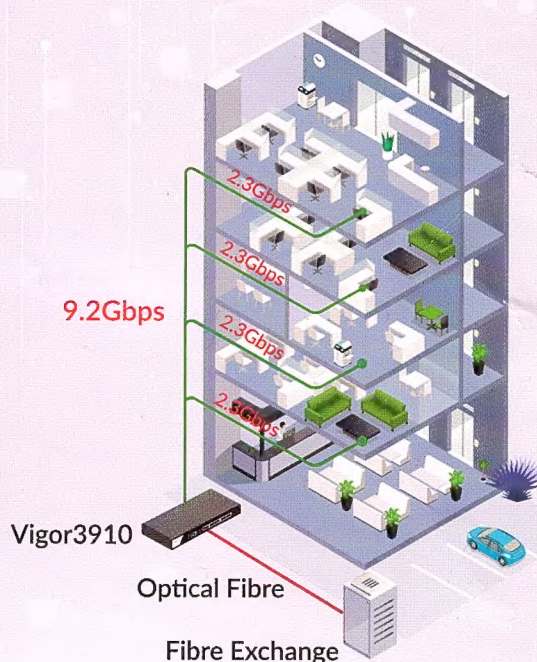


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## EDITORIAL

## WFH FTW

A new normal is upon us.

Are you one of the many that has spent most of 2020 working from home? And, now face at least a few more months of WFH as we await the jab in the arm that will, we hope, rid us of this massive disruption?

Were you caught ill-equipped when it all began, and had to rush into setting up a home office that was an improvement on a laptop at the kitchen table? Did your company scramble to put in place remote working systems to ensure smooth workflow, tight security, and all without having to spend a small fortune?

And if so – how do you feel now about returning to an office full time again?

For a great many, I suspect, perhaps less than keen.

We've all had plenty of time to adapt. And, so have our employers. Does it strike you as slightly crazy that one should rise early in the morning, put on some expensive clothes so we present well to the outside world, and venture off on a potentially long journey, to sit at a desk, or a long impersonal crowded bench – being the new style of worker's paradise – packed in tight with others, working in a sterile and depressing environment on worse equipment than you have at home?

I've come to think this is madness, and I'm not alone. When the world returns to 'normal', well, it won't be the old normal. Across industry – and particularly in tech – many companies have offered employees the opportunity to remote work permanently. It's happening on various scales. Some will expect a day or two in the office – likely scheduled for when team meetings or client presentations need to happen, others are offering complete freedom to WFH five days a week. Or will that soon become four days a week? That's the next frontier, and it's gaining momentum.

Of course I'm well aware there are a great many – perhaps a majority – of industries where it is essential that office workers come in every day. Recalcitrance to change is surely a factor in many, though. Bosses that don't trust their workers unless they can see them, etc. But money talks and the cost of running a fancy CBD office is immense.

It's a massively complex topic. What are the psychological and social implications for people living alone? Who pays for a worker's new laptop? How will tax law change for deductions? And what will become of all those empty city buildings?

It'll be most interesting to see how 2021 unfolds. With so many large companies leading the way and allowing remote working there's already huge momentum. The workers who have taken a shine to all the conveniences and cost savings of WFH will be making some noise. If this was a new concept being proposed today in a fantasy non-COVID world it would undoubtedly sink – but through 2020 hundreds of millions of people, or more, have proven it is not only possible and doable, but desirable and with clear measurable benefits.

BEN MANSILL

*“Were you caught ill-equipped when it all began, and had to rush into setting up a home office that was an improvement on a laptop at the kitchen table? Did your company scramble to put in place remote working systems to ensure smooth workflow, tight security, and all without having to spend a small fortune?”*





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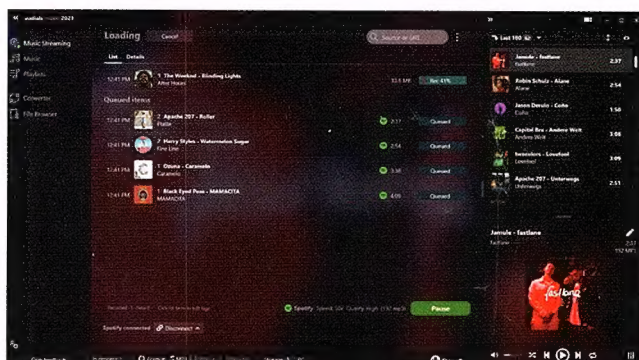
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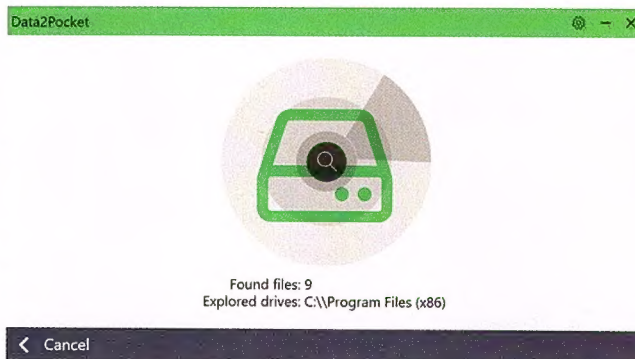
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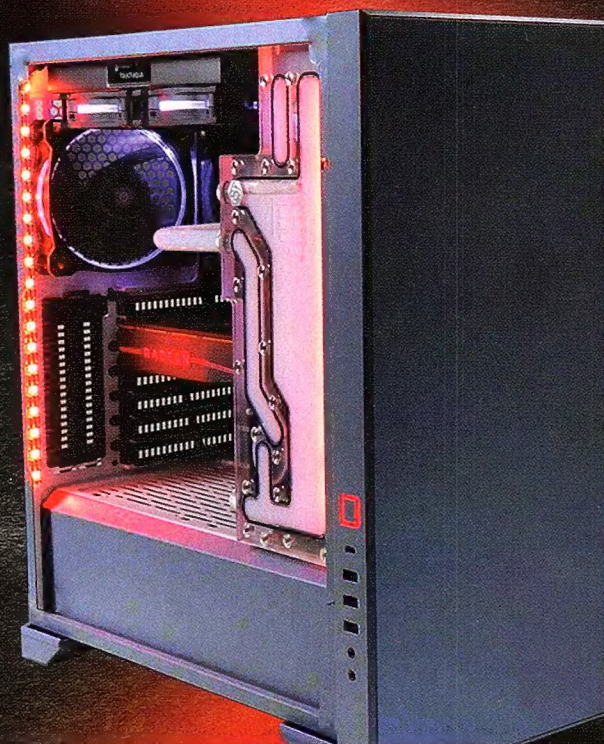
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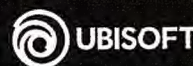
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NVIDIA  
DETHRONED?

## AMD Radeon 6800 & XT

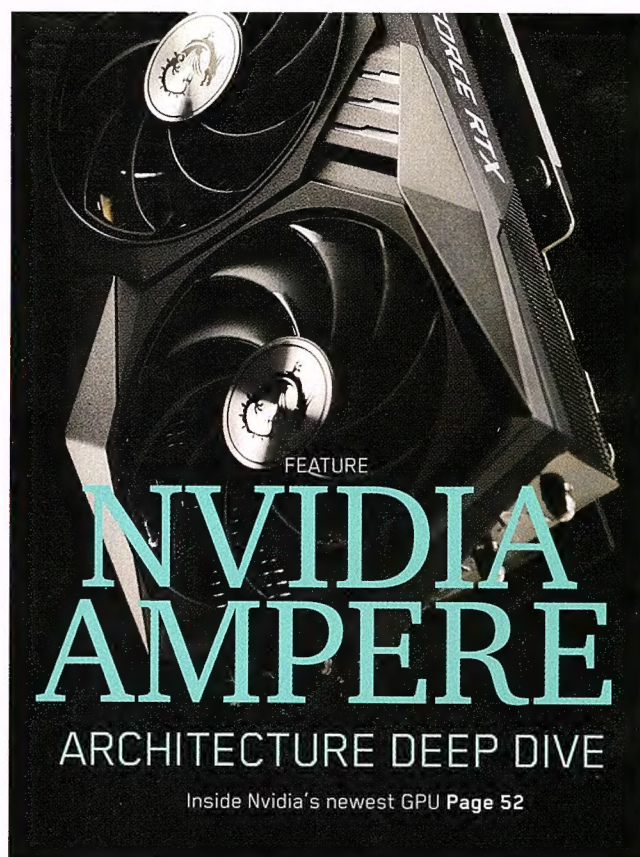
A new era in affordable performance



FEATURE

### Ubuntu blast off!

Ubuntu is back and it's better than ever Page 60



FEATURE

### NVIDIA AMPERE

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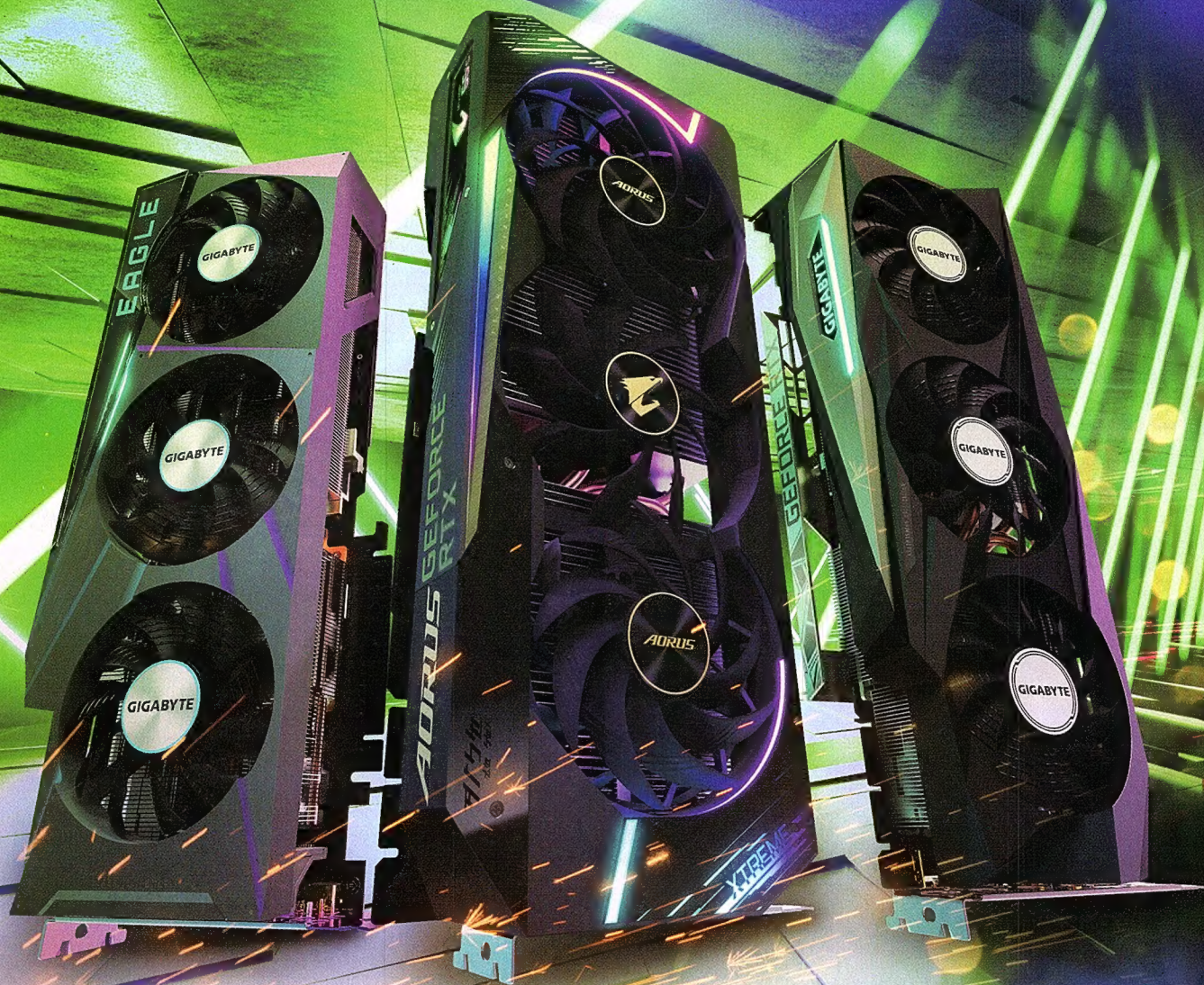
We use both tables and graphs for displaying results; the latter offers better ease-of-readability, but tables are more compact, so we use these in most cases where thoroughness is preferred.

*“APC strives to conduct the most rigorous, objective scientific tests and benchmarks we can so as to make our reviews as unbiased as possible.”*





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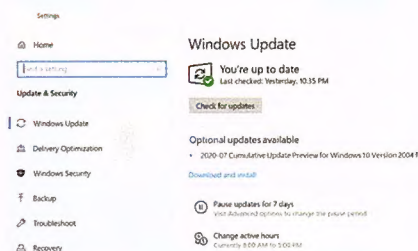


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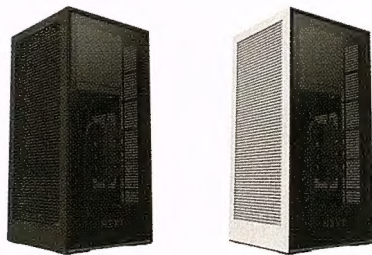


Microsoft tests Windows 10 Feature Experience Packs  
**Not every feature will be tied to the OS.**  
 Microsoft is testing updates to Windows 10 that don't require an entire operating system (OS) overhaul. Yesterday, Microsoft released Windows Feature Experience Pack 120.2212.1070.0 to its beta channel.

The Feature Experience Pack lets the company update certain features that are being developed separately from Windows 10.

"Currently, only a limited number of features are being developed this way, so we are starting out very scoped," a senior program manager at Microsoft, wrote on the *Windows Insider* blog. "By testing this process first with Windows Insiders, we hope to expand the scope and the frequency of releases in the future."

This update will be provided to Insiders through Windows Update, but they will need to be on 20H2 Build 19042.662 already.



Nzxt halts sale of case because it can catch on fire  
**H1 owners advised to power down until repair kit is sent out.**

A pair of screws that attach the PCI Express riser cable inside Nzxt's H1 chassis can cause an electrical short and pose a fire hazard. As a result, Nzxt has temporarily stopped selling the chassis and has advised its reseller partners to do the same.

The issue came to light a couple of months ago, with a Reddit user claiming they saw smoke come from their H1 case when first powering up their PC. Then a few weeks ago, another Reddit user with the same chassis said they saw "flames come out of the case." Having identified the problem, Nzxt is sending out repair kits to H1 owners, which contain "two new screws that address the issue along with instructions to replace them."



BAD NEWS

## PC prices may rise next year

As COVID-19 vaccines make cargo space limited.

Demand for electronics boomed in 2020 as the world dealt with stay-at-home orders and lockdowns. But while this is good news for PC makers, it has also led to logistical challenges, especially with many PC components being in short supply. In the coming months things might get worse as PC makers will have to compete for cargo space with COVID-19 vaccines. In the end, PCs may get more expensive than they are today.

The COVID-19 pandemic had a disruptive effect on all major supply chains. Normally, PC makers, as well as suppliers of various PC components, use air freight for their premium and latest products only. Due to numerous interruptions in the supply chain, the mix of air shipments rose in the recent months, increasing costs. To make matters worse, there are shortages of PC components, including CPUs, display panels and graphics cards.

Among the particularly important components that are in short supply today are LCD panels. These commodity products consist of ingredients – liquid crystal array, backlighting, T-Con boards, drivers, inverters and more – made at different locations. If one of the

elements is missing, the panel cannot be assembled.

In the coming months pharmaceutical companies and governments are expected to start shipping COVID-19 vaccines, using, at least initially, use a lot of air freights. As a result, already elevated air freight costs are likely to increase again. Normally, around 20 percent of notebooks are shipped by air freight, Canalys CEO and president Steve Brazier told *The Register*. Currently, that number has increased to about 30 percent.

Due to high demand, component shortages, and increasing air freight costs, PCs may get more expensive in 2021. "The cost of air freight has been rising all year because, quite obviously, there have been very few planes in the sky," Brazier told *The Register*. "The arrival of the vaccine will mean that there is yet more competition for the very little air freight capacity that currently exists in the world. ... In the old days, only fools bought new PCs for Christmas because they were always so much cheaper in January. That will not be the case this year, when prices could well rise in the New Year."

*"In the coming months pharmaceutical companies and governments are expected to start shipping COVID-19 vaccines, using, at least initially, use a lot of air freights. As a result, already elevated air freight costs are likely to increase again."*



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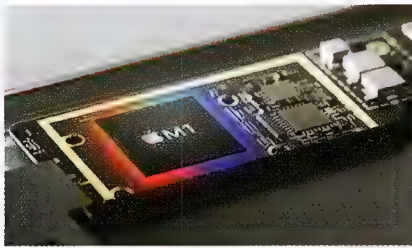


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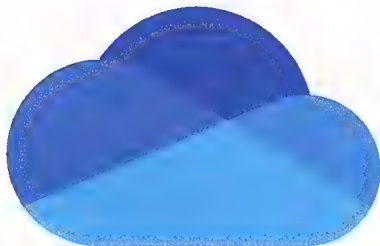


## Apple M1 runs Windows 10 faster than Surface Pro X Apple's first CPU looks to be quite the performer.

A developer using the handle @imbushuo on Twitter has posted Geekbench versions 4 and 5 scores that compare Windows 10 on Arm on an M1 computer with the Microsoft-made Surface Pro X.

Windows on an M1 got a single-core score of 1,288 and multi-core score of 5,685 whereas the Surface Pro X's scores were roughly 800 and 3,000 in those respective benchmarks. Per MSPoweruser, the Surface Pro X benchmark was made using the SQ2 Arm-based chip that was co-developed by Qualcomm and Microsoft for Microsoft's latest Surface Pro X computers.

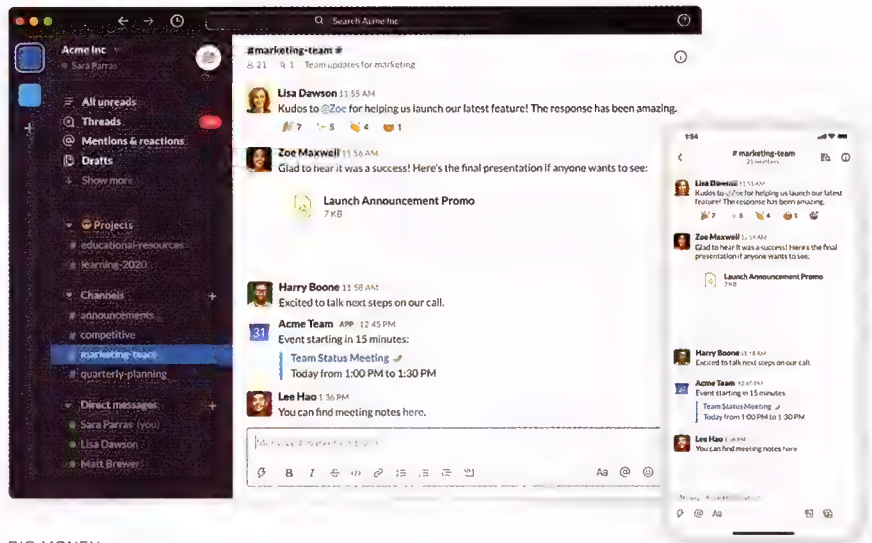
As the report notes, while these results are probably not conclusive, early indications are that Apple's new M1 chips can run Windows on ARM better than Microsoft can, which would be quite something.



## You can now add shortcuts for shared folders to your OneDrive Now easier than ever to manage shared files.

OneDrive has a section for all the files and folders that are shared with you. This is a convenient place to find content that others have shared with you through OneDrive, but it can feel separate from the rest of your OneDrive storage. Now, a new "Add to OneDrive" feature makes it easy to add a shared folder to your own OneDrive files.

To add a shared folder to your own files, you just select it on OneDrive on the web. You can then select Add to my OneDrive in the menu across the top of the screen. This creates a shortcut for the shared folder within your own OneDrive files. Any created shortcuts then appear on OneDrive on the web, Windows File Explorer, in Mac Finder, Teams, and the OneDrive mobile apps.



BIG MONEY

# Slack can now compete with Microsoft

Thanks to \$27.7 billion Salesforce buyout.

Workplace communication has been a major focus of the year, with companies left and right taking advantage of the fact that many employers cannot yet return to the office. Many have been pushing their business tools and productivity apps, while others have been focused on ways to expand their business to better accommodate for the new status quo. The latest expansion comes in the form of Salesforce, as it has announced its acquisition of Slack for a staggering US\$27.7 billion.

Slack went public last year for US\$19 billion before seeing its shares fall. But the offer from Salesforce, which provides a suite of sales and marketing software tools, highlights

just how important it is to meet the new remote workplace demands. Together, the companies plan to combining their extensive app ecosystems to create a comprehensive platform that brings together all aspects of a company's existing workflow.

The move comes just as Amazon announced its own extended partnership with Zoom, which is poised to further take advantage of the growth in video communication. Google and Microsoft have also both seen their daily usage grow significantly this year with their respective communication' ness offerings.

## Hackers used crypto-mining software to avoid detection

Microsoft points out the threat potential of crypto coin miners.

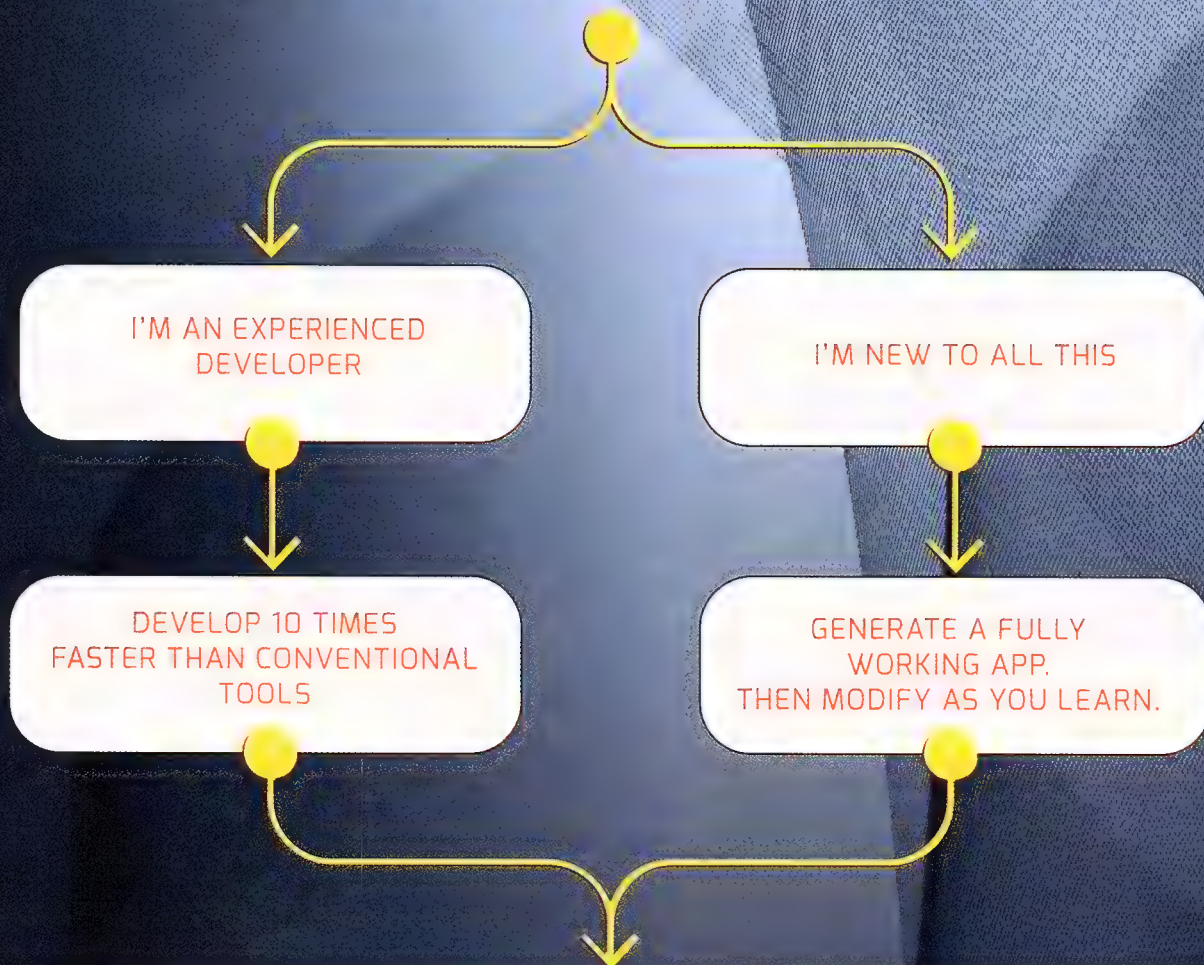
Microsoft has highlighted a growing trend of state-sponsored hackers disguising themselves as financially motivated hackers, rather than being motivated by espionage. The company illustrated this by sharing from the Vietnamese group BISMUTH (via ZDNet). The group recently tried a new tactic that centred around crypto mining, which is different than their normal method of attack.

The Microsoft Defender team explained on Monday: "While this

actor's operational goals remained the same – establish continuous monitoring and espionage, exfiltrating useful information as it surfaced – their deployment of coin miners in their recent campaigns provided another way for the attackers to monetise compromised networks. Considering some of the group's traditional targets are human and civil rights organisations, BISMUTH attacks demonstrate how attackers give little regard to services they impact." ■



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TECH BRIEF

# AMD Precision Boost Overdrive 2

Adaptive undervolting for Ryzen 5000 coming soon.

One of the ways that enthusiasts tinker with their processors is through overclocking: the attempt to get more performance by changing frequencies and voltages, up to the limits of the system. Another way is through undervolting – removing voltage from the processor to help lower temperatures and offer higher thermal headroom (or lower power consumption). It all depends on the silicon, and if it can support it: AMD (and Intel) have to set hard limits for production to enable sufficient yield and costs, but users on certain products can always poke the hardware to try and get something more. With this in mind, AMD is improving its range of overclocking tools to allow for adaptive undervolting of Ryzen 5000 processors.

For any given microprocessor circuit, it requires a minimum voltage to run at a given frequency, before not having enough to complete the process. Most modern processors have a good amount of built-in

headroom such that external factors cannot come into play, such as voltage droop based on instantaneous power draw, or as the processor ages, no extra voltage is required. Obviously, a lower voltage means lower power consumption, or more opportunity for higher boost, and so vendors use a variety of techniques to get their processor cores to run as close to the absolute minimum as possible. Despite this, there is always more room to go – vendors have to define a cut-off point between a realistic voltage tracking technique and something that can be scaled for a million processors. Individual users however can skirt those lines for their specific hardware a lot closer than a generic algorithm can.

AMD's new Curve Optimisation tool, to come with AGESA 1180 on 400-series and 500-series motherboard BIOS updates, is designed for this single-user voltage tracking scenario. The goal of the Curve Optimisation tool is to opportunistically reduce

voltage where possible during low load and high load scenarios, but rather than simply apply a fixed voltage offset across the whole range, it will use other internal sensors (such as workload, temperature, socket limits) to adapt the voltage as required. With AMD's tool, it should do this on the order of one millisecond, i.e. 1000 times a second.

The Curve Optimisation tool will be part of AMD's Precision Boost Overdrive toolkit, meaning that using it will invalidate the warranty on the hardware, however AMD knows that a number of its user base love to overclock or undervolt to get the best out of the hardware. The company states that this adaptive methodology will allow for performance gains in both single-thread and multi-thread workloads, as opposed to a standard voltage offset, which they say only really helps with multi-thread examples.

The settings will allow users to test how much adaptive undervolting will be allowed. AMD has tuned the feature such that a user can select how many 'counts' or 'stages' they want to undervolt by, with each count equating to 3-5 millivolts, up to a maximum of 30 stages. This means that a 10-stage selection will enable a 30-50 millivolt undervolt, depending on the workload and depending on where the control circuitry deems it appropriate.

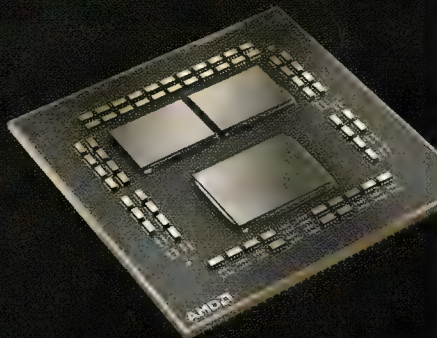
Performance numbers from AMD would suggest that this technique, compared to a simple fixed undervolt and core frequency increase, can lead to a +2% single thread performance improvement, or up to a +10% multi-thread performance improvement for the Ryzen 9 5900X. Users will be able to enable Curve Optimiser through the BIOS initially, with plans to introduce it to AMD's Ryzen Master software toolkit for Windows sometimes in the new year. ■

*"The company states that this adaptive methodology will allow for performance gains in both single-thread and multi-thread workloads, as opposed to a standard voltage offset, which they say only really helps with multi-thread examples."*

## PRECISION BOOST OVERDRIVE 2

### UNDERSTANDING CURVE OPTIMIZER

- Like overclocking, no two processors are alike
- Some processors have more undervolting headroom, some have less
- More headroom when processor load is low, less when load is high
- Typical undervolting only optimizes "worst case" workloads
- Curve Optimizer allows undervolting that can adapt to both light and heavy workloads
- Curve Optimizer tells the firmware what window of undervolting is desired by the user relative to operating conditions



7 AMD PRECISION BOOST OVERDRIVE 2 | NOVEMBER 2020

AMD





# ULTIMATE PERFORMANCE.

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END USER

## Backwards compatibility is the best thing about the PS5 and Xbox Series X

It looks like the big console companies have finally woken up to themselves, writes Shaun Prescott.

The first game I booted up on my freshly unboxed Xbox Series X was the 2010 RPG classic *Fallout: New Vegas*. The first game I booted up on the PlayStation 5 was the 2010 indie platformer *Super Meat Boy*. No, not *Watch Dogs Legion*, or *Dirt 5*: I delayed the gratification of console ray-tracing and next-gen beauty in favour of the reassurance that yes, finally, console companies have woken up to themselves.

The question of backwards compatibility has plagued the console world for decades, but the PlayStation 5 and new Xbox consoles are far from the first to offer such exhaustive support for their previous gen software. The PlayStation 2 was backwards compatible with the PSOne, and the first wave of PS3 consoles were also backwards compatible (the feature was ditched in subsequent waves of production). Nintendo's Wii U supported Wii games, and the first wave of Wii consoles supported Gamecube software and peripherals.

But those are marginal exceptions to the general rule that, historically, a new generation of videogame hardware marks a clean slate, and a wholesale erasure of the past. Years worth of software is immediately antiquated, and if

something isn't also released for PC (the most powerful backwards compatibility machine) it'll fall into emulated obscurity. It's incredibly frustrating if, like me, shiny new games aren't inherently appealing: why should it be hard for me to play Insomniac's not-very-good 2013 shooter *Fuse*? Does the game cease to matter once Microsoft and Sony has moved on?

You can't really argue in the affirmative to that (and no, *Fuse* being a bit crap is beside the point). And anyway, mine and many others' gaming habits aren't really the point either: the adoption of backwards compatibility as an ongoing commitment from Microsoft and (to a more muted degree) Sony is brilliant from a game preservation point-of-view. It may not be the corporate motive, but it's promising that games are considered more than multi-million dollar projects to be heavily marketed during their pre-launch period, only to be abandoned in the following months.

In reality, the motive was probably shaped by how much games changed throughout the course of the PS4 / Xbox One generation. The rise of the game-as-a-service model means that whole droves of players stick to one or two "hobby games," rather than fork out for \$100



**SHAUN PRESCOTT**

Author, PC gamer and passionate technology observer, Shaun covers trending tech topics for APC.

blockbuster every couple of months. Put it this way: what hope would a PS5 or new Xbox have if the following games didn't work right out of the box? *Fortnite*, *Rainbow Six Siege*, *PlayerUnknown's Battlegrounds*, *Destiny 2*, *Fall Guys*, *Rocket League*, *Genshin Impact*, *Final Fantasy XIV*... the list goes on.

All of these games command multiple thousands and sometimes millions of return players every month. Some are free-to-play, and some aren't. But the days of the big holiday season blockbuster dominating mindshare for a couple of weeks before moving over for the next are long past us. Sure, the likes of *Red Dead Redemption 2*, *The Last of Us Part Two* and *Cyberpunk 2077* still inhabit that space, but they're part of a rarer breed nowadays. Most blockbusters are here one day, gone the next: remember *Marvel's Avengers*?

While it might be wishful thinking on my part, it seems like backwards compatibility is here to stay. No other modern eco-system, like smartphone platforms for example, would get away with it. It may stymie publisher's attempts to sell prettier versions of their older games on new platforms, but, well... that seems like a positive development to me. ■





RANDOM ACCESS

# Facebook's biggest growth factor is conspiracy theories

Fake news is more popular than the truth and Facebook can't afford to ditch it entirely.

Facebook has a problem: Fake news is popular. So popular that the company threatens to lose growth, or even contract if it's too aggressive in telling people that popular news stories are factually inaccurate.

As part of the company's "Break Glass" initiative that was set up to combat misinformation in the event of a contested 2020 US election, Facebook established a NEQ (News Ecosystem Quality) ranking to quantify the reliability of news sources and prioritise posts from reputable outlets. Once it became clear that Joe Biden would be the next democratically elected president of the United States, Facebook dramatically increased the weighting of its NEQ prioritisation to boost the visibility of established news organisations and suppress more dubious and polarising sources like *Breitbart* and *Occupy Democrats*.

While many employees asked for the permanent instatement of the NEQ prioritisation, Integrity Division Facebook Executive, Guy Rosen, stated that the news ranking changes were always intended to be temporary. He also mentioned that though Facebook would reverse these changes it

intended to study their effects.

Engineers and Data Scientists from Facebook posted the findings from a collection of experiments known as "P(Bad for the World)" on an internal company network in November that was later assessed and reviewed by *The New York Times*. The findings give a little insight into why the company is so reluctant to stamp out misinformation in a blanket rankings approach.

Essentially the company surveyed users' opinions on whether posts were 'good for the world' or 'bad for the world' and found that the majority of high-reach (viral) posts were deemed 'bad for the world'. Facebook then used this dataset to train a machine learning algorithm to predict whether posts were good or bad and used this algorithm to demote objectionable content in feeds. While this resulted in fewer bad posts being visible in feeds, it also negatively impacted the amount of time people spent on Facebook. The company ran a second study on a less aggressive curbing of problematic stories and found that while it let more through, it didn't reduce user's time on the site.



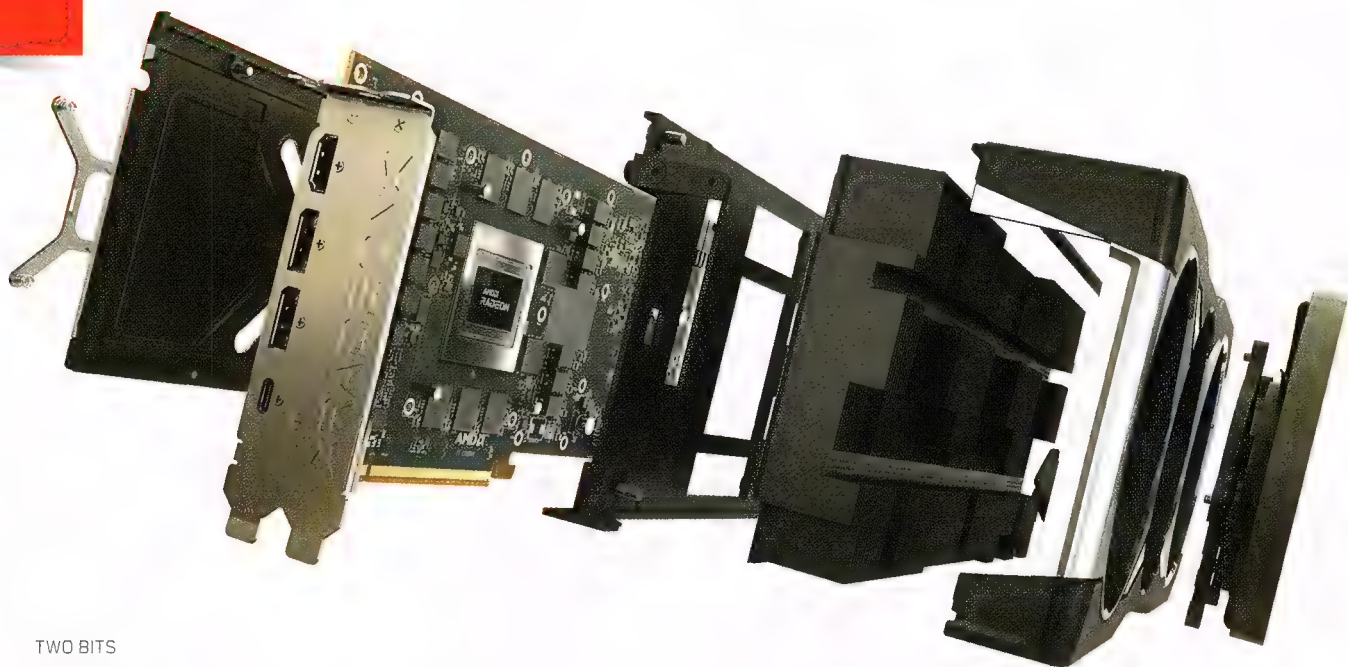
**JOEL BURGESS**

When not reviewing PCs for APC and writing our funny pages, Joel likes to ponder tech and how it's used.

This second iteration of the algorithm was eventually integrated into the site, but other projects including "Correct the Record", which issues retroactive notifications for anyone that interacted with fake news, have been vetoed or constrained to particular topics like COVID-19 misinformation. The *Times* reported that sources close to the matter said this particular tool was barred by company policy executives who feared it would disproportionately curb right-wing publishers, but Facebook has denied that this was the reason for not expanding the tool.

A lack of progress in the truth vs profitability equation seems to be affecting staff pride, according to a company report only half of the employees now feel as though Facebook has a positive impact on the world – down from three-quarters in the middle of 2020. At least there's likely to be less pressure on 'anti-conservative bias' from the White House moving forward, which might encourage the company to take a stronger stance on misinformation. ■





TWO BITS

# Why does AMD get flak for having poor GPU drivers?

Fact or fiction?

Now that the RDNA2-based RX 6000 series has launched, it's worth revisiting one of the enduring topics that pops up regarding AMD's GPU driver quality, or lack thereof. AMD has experienced periods where its drivers have been under par. Some of the poorer periods go back to a time when AMD was struggling to remain solvent and even before that during the ATI days, but more recently some issues persist including intermittent black screening with its RX 5000 series cards. I haven't personally experienced any such issues, though I tend to use fresher Windows installations with less accumulated rubbish on them.

No driver can ever replicate all of the millions of hardware and software combinations out there but honestly, over many years of testing all kinds of Nvidia and AMD GPUs, Nvidia has tended to have its nose in front when it comes to stability and reliability, particularly in the pre-launch phase when we do most of our testing. We do feel that AMD's reputation is a little undeserved

but sometimes some of the criticism is warranted. No doubt this has cost AMD a few points of market share over the years. Such issues endure in the minds of many.

Now that AMD has experienced its Ryzen moment with its new RDNA2 graphics cards, the time has come for it to prioritise its driver development while enthusiasm is at its peak. The last thing it needs is a reinforcing of old sentiments when the company is firing on all cylinders hardware-wise. AMD isn't the cheapie underdog anymore. It's the real deal and it's shown it's capable of challenging and beating Intel and Nvidia head on. Now it has to make strides with its software. Major incoming developments including ray tracing support and FidelityFX Super Resolution (AMD's DLSS competitor) will need special attention to work as flawlessly as possible from day one on the vast numbers of varied systems out there.

A kind of backhanded praise that AMD has attracted over the years is its ability to deliver



**CHRIS SZEWCZYK**

A life-long PC tech enthusiast,

Chris has worked across the industry in many areas as a product and technology expert.

performance gains over the lifetime of a product. Like a 'fine wine' one might see it referred to, where performance matures over time. A notable example from a few years back was the case of the HD 7970 vs the GTX 680, where the former gained a lot of performance in newer DX12 and Vulkan titles. Will we see the same with the new Microsoft DXR? This, along with things like leveraging Infinity Cache, Smart Access Memory and FidelityFX technologies means there's a lot of development happening, which in turn means a huge necessity for scaling up quality control and internal testing resources.

The incoming massive console user base combined with thousands of developers working with RDNA2 means there is a huge opportunity to optimise and unleash the full potential of the new architecture. The pressure is on AMD. It's all there for the taking. AMD should – to continue to grow its CPU market – share a strong roadmap. Add to this a brand new highly competitive and widely adopted gaming architecture with a couple of hundred million users over the coming years and the future is bright. Now AMD needs to add a polished and a refined software and development ecosystem to bury enduring doubts about driver quality. ■

*"Now that AMD has experienced its Ryzen moment with its new RDNA2 graphics cards, the time has come for it to prioritise its driver development while enthusiasm is at its peak. The last thing it needs is a reinforcing of old sentiments when the company is firing on all cylinders hardware wise."*



# Infinity cache

Changing the VRAM paradigm.

It's clear AMD has a new-found love for cache. Reworking the L3 cache on Zen 3 appears to be paying dividends when it comes to CPU performance, but AMD is going a step further with Big Navi, adding what it calls the Infinity Cache, with 128MB of basically L3 cache to reduce bandwidth contention.

Officially, the chip is Navi 21 and will show up in Radeon RX 6900 XT, 6800 XT, and 6800 GPUs. But taking a cue from the enthusiast community, AMD has adopted the name Big Navi. And it really is big.

Big Navi contains 26.8 billion transistors, which is just five percent shy of Nvidia's GA102 chip. But the way AMD and Nvidia are using those billions of transistors is very different. Looking at the die shot, the Infinity Cache occupies about 17 percent of the total chip area – it could be more, but the provided

die shots often have artistic interpretations, so there's a margin of error.

To put that into perspective, all of the 80 compute units (CUs), which are primarily responsible for the graphics computations, only occupy about 31 percent of the die area. Video interfaces, memory controllers, hardware codecs, texture units, ROPs, and other elements make up the remainder of the die. But the ratio of area used on cache versus other functional blocks is very much skewed in favor of cache compared to other GPU architectures.

Why would AMD use such a big cache? Based on early performance figures from AMD, it's a major part of what will allow Big Navi to compete with Nvidia's Ampere architecture.

Radeon RX 6800 XT as an example comes with 72 CUs and 4,608 shader cores, compared to the RTX 3080's 68 SMs and 8,704



**JARRED WALTON**

Jarred Walton has been a PC and gaming enthusiast for over 30 years.

The Infinity Cache is all the teal-coloured area at the top and bottom.

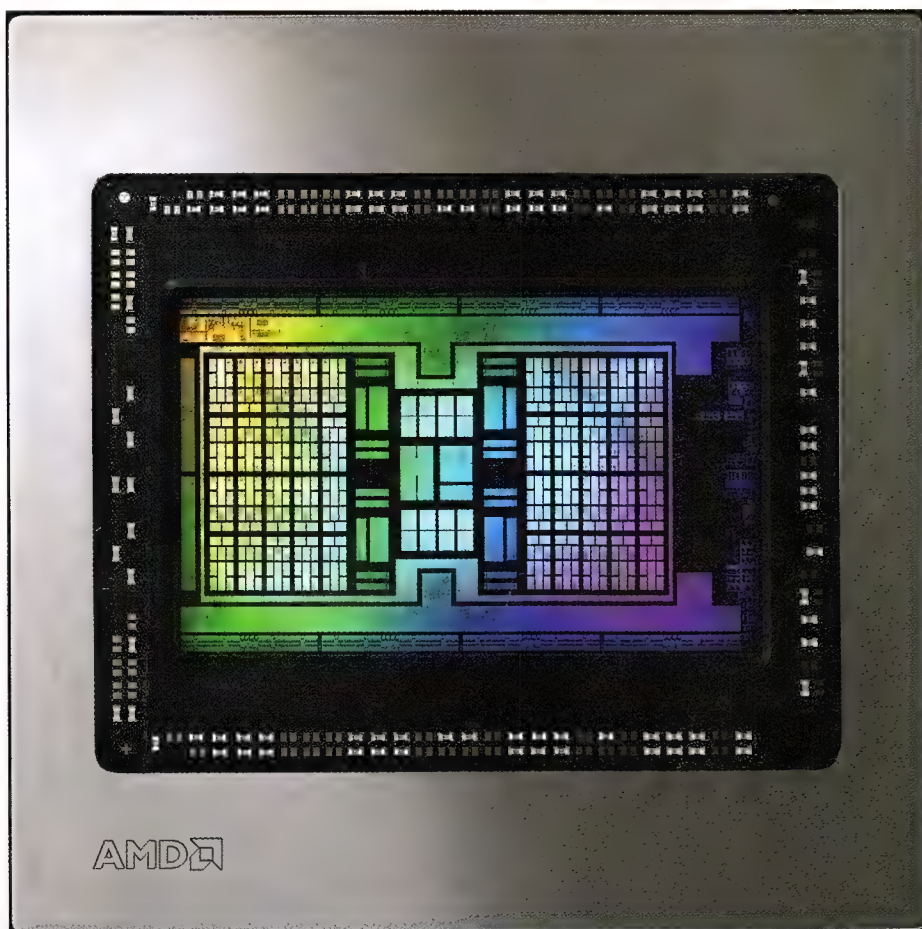
shader cores. AMD does clock its chip a bit higher this round, with a game clock of 2,015MHz compared to Nvidia's boost clock of 1,710MHz, but that's still theoretical compute performance of 29.8 TFLOPS for the 3080 vs. just 20.7 TFLOPS on the 6800 XT. What's more, AMD is using a relatively paltry 256-bit interface with 14Gbps memory, providing the same 448GB/s of bandwidth as current RX 5700 XT cards – though AMD does double-down on the VRAM capacity by moving to 16GB. RTX 3080 has 760GB/s of bandwidth.

On paper, then, Nvidia offers over 40 percent more compute and 70 percent more bandwidth. And traditionally Nvidia has made better use of both in its GPUs, so we would expect this to be a landslide victory for Nvidia. Except, the Infinity Cache radically changes expectations.

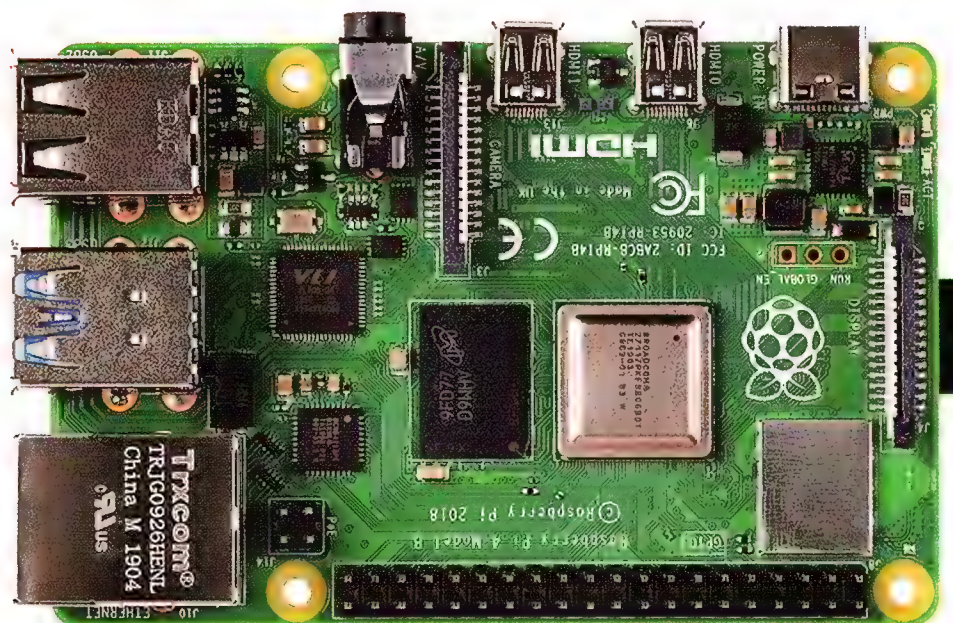
128MB is large enough to easily hold several copies of a 4K frame-buffer. That means a lot of the z-buffer and frame-buffer accesses will skip the GDDR6, and AMD claims the effective bandwidth thanks to Infinity Cache is 117 percent higher than on Navi 10. That's the equivalent of 948GB/s, which suddenly makes AMD's chips look far more competitive.

The verdict is still out on ray-tracing performance. AMD says the hardware ray accelerators (RAs) are 10 times faster than doing ray calculations via shaders, which is similar to Nvidia's claims with Turing. But Ampere is supposed to be about 70 percent faster per RT core when it comes to ray tracing. Nvidia also has DLSS 2.0 used in several games, with more on the way. AMD's working on FidelityFX Super Resolution, which appears to take a similar approach, but it won't be available for games for months.

Still, that big L3 cache is a wild card that can change efficiency and performance in lots of ways. Latencies are reduced, efficiency improves, and potentially we end up with AMD 300W GPUs matching or exceeding the performance of Nvidia's 320W and 350W GPUs. ■







The Raspberry Pi 4 starts at \$35 for the 2GB model.

OPEN SOURCE

# Why you need some Pi

Satisfy that building itch.

There's nothing quite like the thrill of building a computer, but there's an equally exciting way to scratch your building itch: Raspberry Pi.

Launched in 2012 and now in its 4th major generation, Raspberry Pi is the inexpensive ARM-powered, single-board computer that will change your tech life. The Raspberry Pi 4 has enough quad-core performance to do web surfing, productivity work and programming, but if you buy one expecting to use it as a substitute PC, you'll be disappointed.

What makes a Raspberry Pi compelling is its ability to power all kinds of project you wouldn't or couldn't use an x86 PC for. Want to build a Game Boy-sized console emulator powered by Intel or AMD? Good luck cramming your micro ITX motherboard and PSU into the case. How about an IoT device to alert you when you're out of toilet paper? To what PC motherboard will you wire the distance sensor you need?

You can use a Raspberry Pi for everything from a home media server to a smart Geiger counter to

a high-powered robot. The Raspberry Pi's 40 GPIO (general input/output) pins give it the ability to interface directly with lights, motors, and sensors, or to use a huge ecosystem of add-on boards called HATs (hardware attached on top) that won't work with a PC.

The Raspberry Pi is also really good at doing emulation. You can easily build a retro arcade cabinet or console, and by using a popular emulation platform like RetroPie, you can run games that originated on a smorgasbord of platforms, from old-school arcade machines up to the Nintendo 64.

Though there are more than 20 operating systems that run on Raspberry Pi, the most popular is the official platform: Raspberry Pi OS, a fork of Debian Linux. Because it runs Linux and uses very little power (a max of 15 watts, but usually no more than 7.6 watts under load and 3.4 at idle), the Pi makes a great server that can get juice from a typical USB charger or sip battery power from a standard power bank.



**AVRAM PILTCH**

Avram Piltch is the Editor-in-Chief of *Tam's Hardware* where he hosts the Pi Cast, a weekly Raspberry Pi Podcast.

There are other single-board computers on the market, some of which are blatant clones with names like Banana Pi and Orange Pi, but what makes Raspberry Pi such a success is the support of a huge community that not only answers questions on forums, but also writes tons of open-source software for it. The Raspberry Pi Foundation, the organisation behind the board, has sold more than 30 million units, and Reddit's [/r/raspberrypi](https://www.reddit.com/r/raspberrypi) alone has 2.1 million members.

You might ask: "Do I need more devices?" Living your best tech life isn't about raw utility, but the thrill of learning and problem-solving, the same you get from a challenging PC build but on steroids.

Best of all, if you're a parent, you can use Raspberry Pi projects to learn alongside your kids. My eight-year-old and I have been building robots and retro systems for more than a year, and now he can program in Python, the most popular language for Pi projects, while other kids his age are still learning block-based coding. That's not bad for a computer that costs less than some mice! ■

*"What makes a Raspberry Pi compelling is its ability to power all kinds of projects."*



# HOW IT'S DONE

TAKING THINGS APART AND HAVING A POKE AROUND



This  $\mu$ -blox GPS processing module was released way back on June 29, 1999!



## FBI tracking device

We hope you didn't expect this one would be easy...

We're taking a sneak peek inside an FBI tracking device, similar to the one Yasir Afifi found on his car.

Disclaimer: We love the FBI. We've worked with them on several occasions to fight crime and locate criminals. We've helped them with instructions on gaining entry into certain devices. We have nothing against them.

### Major tech specs

- Battery pack
- GPS antenna
- XEMICS XE1201 Ultra-low-power single-chip transceiver
- RFM RF1172 SAW (surface-acoustic-wave) filter
- Magnetic mounting bracket

### KEY FINDINGS

- We finally have one of these on the teardown table! The components of the system are all attached to a vehicle with powerful magnets. What tech keeps this device powered? Let's remove the battery pack's end cap. It's powered by four lithium-thionyl chloride D-cell batteries. Each cell is good for 13,000 mAh, about double the capacity of the iPad 2's battery. The cells are suited to low-draw applications where longevity is needed, with a service life of

10-20 years.

- To begin tearing the device apart, we detach the two antennas from their screw-in mounts. The shorter antenna is responsible for transmitting the location signal to transponders that the FBI would use to find someone. The larger antenna is for receiving GPS signals from satellites. Removing a few Phillips screws lets us access the innards of the GPS antenna. It's attached to its bracket with Velcro.
- Let's turn our attention back to the transmitter/receiver module. A few screws are all that remain between us and the innards of this invasive device. The rear cover is simply a method to connect the module to power. Presumably, different batteries can be connected to make the tracking device more universally installable.
- To get to the brains of the module, we focus on the other end cap. The FBI really doesn't want anyone tampering with the innards of their tracking devices. The screws are coated with so much threadlocker that we have to break out the power drill and eliminate the screw heads.
- Upon drilling out all the screw



The screws were coated with so much threadlocker that we had to break out the power drill and eliminate the screw heads.

heads, the outer case slides off the transmitter/receiver assembly. The two modules can be split apart to examine their circuits. A small blue wire connects the GPS antenna to the GPS receiver board. After disconnecting the GPS board, we can take a closer look.

- The module providing the GPS signal-processing is a  $\mu$ -blox GPS-MS1 that's ancient in the realm of modern electronics. It features 0.125MB of SRAM and 1MB of flash memory. The imperfect alignment of the SMD components on the board indicates that the FBI hand-soldered them.
- The larger of the two boards contains the connections for both antennas and is responsible for the RF side of the tracking device. The XE1201 chip allows for data transmission and data reception, while the RF1172 provides front-end selectivity in 433.92MHz receivers.
- Repairability Score: -10 out of 10 (10 is easiest to repair). The FBI will find you if you find their tracking device. You cannot choose to not be tracked by the FBI. You can legally be tracked by one of these units. We'll be right back... ■



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# GADGETS

NICE THINGS TO HAVE, FOR YOUR PC AND BEYOND



US\$250 | [clockworkpi.com](http://clockworkpi.com)

## Clockwork DevTerm

An awesome looking portable code analysis tool for true cyberpunks.

Indie hardware manufacturer Clockwork, best known for its popular Gameboy clone the GameShell, has developed a portable coding machine that looks like it's straight out of *Snowcrash*. The DevTerm, as this old-school-looking portable laptop is known, consists of a mechanical keyboard and a screen that lies flat just above it in a similar style to the earliest laptops. The lightweight computing device is powered by a Raspberry Pi CM3+ Lite or a similar Clockwork Pi mainboard, so it's only really capable of running things like server tests and code debugging on the Linux OS.

1TB \$500 | [shop.westerndigital.com](http://shop.westerndigital.com)

## WD Black D50 Game Dock

Add an ultra fast SSD expansion drive to your gaming laptop dock.

It can get kind of tricky to know which type of display adapter you'll need to run games at higher resolutions/ frame rates on an external monitor and, generally, you can pretty much write off the option of connecting to an external monitor through a dock. WD has managed to combine a gaming display dock that has a bunch of convenient connections and can carry gaming grade visuals. The highlight however, is a bundled NVMe SSD that's included in the dock's chassis. You will need a Thunderbolt 3 port to connect it to (anything less just doesn't have the data bandwidth to transfer 4K+/120Hz+ and anything else), but if you can it's the perfect dock for your gaming laptop.







£599.00 | [shop.openbionics.com](http://shop.openbionics.com)

## Metal Gear Solid Bionic Arm

A robotic prosthetic forearm that won't cost you ...  
um ... too much.

It's not every day that you're a little bit jealous of someone who has lost their arm, but the legends at Open Bionics have made a prosthesis cool enough that you may just find yourself thinking it might not be so bad if you had to be a cyborg. Collaborating with Konami Digital Entertainment, Open Bionics have added a *Metal Gear Solid* skin that you can slip onto one of the company's 3D printed bionic Hero Arms. These amazing devices are available from around US\$3,000, much cheaper than competing medical devices that can cost up to US\$95,000.



\$TBC | [nike.com](http://nike.com)

## Nike Air Jordan XI Adapt

Electric kicks that'll have you walkin' on air.

Humans have wanted self-lacing sneakers since *Back to the Future 2*, and while Nike has done a couple of short runs of them over the years, there's generally only enough made to satisfy the most eager collectors. Nike now looks to finally be adapting its self-lacing technology to some non-novelty ranges of sneakers. The latest, the Air Jordan XI Adapt, features the Nike Adapt auto-lacing technology which should adjust the fit of the shoe as you train or play to ensure a consistent fit over a session. You can even change the colour of the shoe's lights and its pattern.



\$39.95 | [microsoft.com/en-au](http://microsoft.com/en-au)

## Microsoft Number Pad

Do the maths on a more efficient numerical typing experience.

It's unlikely that you're going to find a Bluetooth number pad as exciting as some of the other items in Gadgets this month, but if you work with a lot of spreadsheets, coding applications or architectural software, then a good numpad is critical. This low profile keyboard accessory works well with compact laptops and ten-keyless desktop keyboards alike, maintaining that minimalist aesthetic and compact footprint seen on the rest of the Surface range. While it doesn't include a rechargeable battery, the included CR2032 should only need to be replaced every couple of years. ■



\$96.10 | [gamesir.hk/products/gamesir-x2](http://gamesir.hk/products/gamesir-x2)

## GameSir X2

A slick, Switch-like controller for your smartphone.

If you're holding out for Google's game streaming service, Stadia, to arrive Down Under, you're probably in the market for a good game controller, and the Hong Kong-made GameSir X2 looks like it could be a solid option. We've seen a few smartphone controllers add Joy-Con-like remotes to the sides of your smartphone, but none that have looked quite so similar to Nintendo's creation. According to the marketing the key feature of the X2 is the minimal delay in response time, and while there's no mention of how this is achieved, we suspect that the wired USB-C connection is at least potentially faster than something connected over Bluetooth.





6800: \$949, 6800 XT: \$1,049 | www.amd.com

## AMD Radeon RX 6800 & RX 6800 XT

AMD returns to the high-end GPU market at last.

It's a fantastic time to be a PC gamer. Not only do we have some great new and upcoming games, but we also have powerful new graphics cards from Nvidia and now AMD to play them on. Nvidia's Ampere cards have had time in the spotlight but now it's AMD's turn with the release of the all new and long awaited 'Big Navi' RX 6800 series consisting of the RX 6800 and RX 6800 XT. They are soon to be joined by the flagship RX 6900 XT. These new cards represent

AMD's best opportunity in many years to compete head to head with Nvidia at the top end of the market. Do these new cards have what it takes to shake up the GPU market in the same way AMD's Ryzen 5000 CPUs have done?

AMD publicly teased the RX 6000 series in October. Given that 1st generation RDNA 5700 cards offered around RTX 2070 class performance, we were quite stunned when AMD claimed the 6800 XT could compete not just



**SPECS**  
**AMD RADEON RX 6800**  
3840 Shader Units; 1700MHz Base Clock, 2105MHz Boost Clock; 16GB GDDR6 16Gbps memory, 512GB/s Memory Bandwidth; 2x Display Port 1.4, 1x HDMI 2.1, 1x USB-C VirtualLink; 2x 8-Pin Power Connectors, 250W TDP.

with the 3070, but the 3080 too. The 3080 stunned us with a massive generational performance leap so AMD's claims were pretty bold. There are a lot of headline features. AMD has introduced its hardware based ray tracing for the first time, along with 16GB of memory on the standard SKUs to go along with stunning gains in performance per watt. We'll have to reserve judgement until we see the likes of RX 6700 or 6600 class cards in the future but it seems as though AMD has experienced its 'Ryzen moment' with regards to its GPUs. Let's take a look at what makes these cards tick. We have the classy looking reference AMD RX 6800 and 6800 XT cards on hand for our analysis.

*"Perhaps the most remarkable architectural end result is the leap in power efficiency. Without any change in process technology, AMD has managed to significantly increase shader counts and frequencies without resorting to brute force to do it."*

|                               | TEMPS @ |      | 3DMARK           |                     |
|-------------------------------|---------|------|------------------|---------------------|
|                               | IDLE    | LOAD | TIME SPY EXTREME | FIRE STRIKE EXTREME |
| ■ Best result                 |         |      |                  |                     |
| ■ On test                     |         |      |                  |                     |
| AMD Radeon RX 6800 XT         | 43      | 73   | 8,204            | 22,462              |
| AMD Radeon RX 6800            | 42      | 66   | 7,226            | 19,956              |
| Nvidia GeForce RTX 3080 FE    | 34      | 74   | 8,515            | 20,033              |
| Nvidia GeForce RTX 3070 FE    | 38      | 73   | 6,756            | 16,378              |
| Nvidia GeForce RTX 2080 Super | 38      | 72   | 5,524            | 13,285              |
| AMD Radeon RX 5700 XT         | 37      | 82   | 4,469            | 12,356              |

### Under the hood

The all new RDNA2 architecture incorporates many under-the-hood changes. At a high level some of the interesting ones include what AMD calls Infinity Cache, which is effectively a 128MB level 3 cache. AMD claims this removes the need for expensive GDDR6X or HBM memory or a wider bus. AMD claims this low latency on die memory (with 2TB/s of bandwidth!) will deliver benefits for its ray tracing performance. Let's see how it develops in time as the software



ecosystem catches up.

Perhaps the most remarkable architectural end result is the leap in power efficiency. Without any change in process technology, AMD has managed to significantly increase shader counts and frequencies without resorting to brute force to do it. AMD claims its RDNA2 cards gain over 50% in performance-per-watt over 1st generation RDNA cards. In an era where power efficiency often takes a back seat to outright performance, this is something that should be applauded. Another interesting development is so-called AMD Smart Memory, which allows Ryzen 5000 CPUs to access the high speed GDDR6 GPU memory. We'd have to test this independently but AMD claims that a gain of up to 11% in gaming performance is possible.

*“Both the 6800 and 6800 XT make use of the Navi 21 GPU which is built on TSMC’s 7nm process. It’s a big die at 519.8mm² and it packs in 26.8 billion transistors.”*

Both the 6800 and 6800 XT make use of the Navi 21 GPU which is built on TSMC’s 7nm process. It’s a big die at 519.8mm² and it packs in 26.8 billion transistors. Both use a 256-bit bus connected to 16GB of GDDR6 memory. The 6800 features 3,840 shaders that have an on-paper boost clock of 2,105MHz, while the 6800 XT packs in 4,608 shaders at up to 2,250MHz. These kinds of clocks are very impressive and in fact are on the conservative side as we saw both the 6800 and XT able to boost above 2300MHz!

The design of the RX 6800 cards themselves is a huge leap forward in every aspect. Both cards truly look like premium designs with nice metallic construction and splashes of red along the side. Both coolers are very similar but the 6800 XT cooler is a bit thicker and requires three slots, giving it a larger fin surface area. Both feature a full metal back plate and a vapour chamber copper base plate. The quality 15 phase VRM and memory all have thermal pads and the triple 90mm fans incorporate a zero fan speed mode under idle or low load conditions. Both cards feature two DisplayPort 1.4, one HDMI 2.1, and one USB type-C with DisplayPort pass-



**SPECS**  
**AMD RADEON RX 6800 XT**  
4608 Shader Units; 1825MHz Base Clock, 2250MHz Boost Clock; 16GB GDDR6 16Gbps memory, 512GB/s Memory Bandwidth; 2x Display Port 1.4, 1x HDMI 2.1, 1x USB-C VirtualLink; 2x 8-Pin Power Connectors, 300W TDP.

Best result  
On test

| METRO: EXODUS              |                                   |                                   |                                   |
|----------------------------|-----------------------------------|-----------------------------------|-----------------------------------|
|                            | 1920X1080 ULTRA<br>PRESET AVG FPS | 2560X1440 ULTRA<br>PRESET AVG FPS | 3840X2160 ULTRA<br>PRESET AVG FPS |
| AMD Radeon RX 6800 XT      | 123.6                             | 101.6                             | 64.1                              |
| AMD Radeon RX 6800         | 107.3                             | 87.6                              | 55.3                              |
| Nvidia GeForce RTX 3080 FE | 130.0                             | 105.9                             | 68.7                              |
| Nvidia GeForce RTX 3070 FE | 103.1                             | 81.4                              | 51.1                              |
| Nvidia GeForce RTX 2080 Ti | 108.6                             | 85.4                              | 54.1                              |
| AMD Radeon RX 5700 XT      | 73.3                              | 57.7                              | 35.7                              |

| GHOST RECON: BREAKPOINT    |                                   |                                   |                                   |
|----------------------------|-----------------------------------|-----------------------------------|-----------------------------------|
|                            | 1920X1080 ULTRA<br>PRESET AVG FPS | 2560X1440 ULTRA<br>PRESET AVG FPS | 3840X2160 ULTRA<br>PRESET AVG FPS |
| AMD Radeon RX 6800 XT      | 136                               | 110                               | 68                                |
| AMD Radeon RX 6800         | 122                               | 97                                | 60                                |
| Nvidia GeForce RTX 3080 FE | 122                               | 101                               | 69                                |
| Nvidia GeForce RTX 3070 FE | 107                               | 86                                | 52                                |
| Nvidia GeForce RTX 2080 Ti | 107                               | 86                                | 56                                |
| AMD Radeon RX 5700 XT      | 90                                | 67                                | 17*                               |

\* Memory size limited

| MIDDLE EARTH: SHADOW OF WAR |                                   |                                   |                                   |
|-----------------------------|-----------------------------------|-----------------------------------|-----------------------------------|
|                             | 1920X1080 ULTRA<br>PRESET AVG FPS | 2560X1440 ULTRA<br>PRESET AVG FPS | 3840X2160 ULTRA<br>PRESET AVG FPS |
| AMD Radeon RX 6800 XT       | 200                               | 168                               | 94                                |
| AMD Radeon RX 6800          | 175                               | 132                               | 78                                |
| Nvidia GeForce RTX 3080 FE  | 193                               | 150                               | 96                                |
| Nvidia GeForce RTX 3070 FE  | 161                               | 116                               | 71                                |
| Nvidia GeForce RTX 2080 Ti  | 166                               | 12                                | 75                                |
| AMD Radeon RX 5700 XT       | 116                               | 78                                | 47                                |

| TOTAL WAR: WARHAMMER II    |                                   |                                   |                                   |
|----------------------------|-----------------------------------|-----------------------------------|-----------------------------------|
|                            | 1920X1080 ULTRA<br>PRESET AVG FPS | 2560X1440 ULTRA<br>PRESET AVG FPS | 3840X2160 ULTRA<br>PRESET AVG FPS |
| AMD Radeon RX 6800 XT      | 144.1                             | 118.3                             | 65.0                              |
| AMD Radeon RX 6800         | 139.3                             | 107.2                             | 58.4                              |
| Nvidia GeForce RTX 3080 FE | 155.3                             | 126.8                             | 76.2                              |
| Nvidia GeForce RTX 3070 FE | 128.9                             | 97.9                              | 54.6                              |
| Nvidia GeForce RTX 2080 Ti | 136.8                             | 101.4                             | 56.5                              |
| AMD Radeon RX 5700 XT      | 89.7                              | 61.9                              | 32.9                              |

| SHADOW OF THE TOMB RAIDER  |                                   |                                   |                                   |
|----------------------------|-----------------------------------|-----------------------------------|-----------------------------------|
|                            | 1920X1080 ULTRA<br>PRESET AVG FPS | 2560X1440 ULTRA<br>PRESET AVG FPS | 3840X2160 ULTRA<br>PRESET AVG FPS |
| AMD Radeon RX 6800 XT      | 194                               | 143                               | 77                                |
| AMD Radeon RX 6800         | 175                               | 125                               | 68                                |
| Nvidia GeForce RTX 3080 FE | 195                               | 145                               | 83                                |
| Nvidia GeForce RTX 3070 FE | 160                               | 114                               | 62                                |
| Nvidia GeForce RTX 2080 Ti | 164                               | 114                               | 63                                |
| AMD Radeon RX 5700 XT      | 118                               | 79                                | 41                                |

CPU: Intel Core i9-10900K @ 5.1 GHz all cores, Motherboard: Asus Maximus XII Apex, RAM: 2x8GB Team T-Force Xtrem ARGB 3600 MHz 14-15-15-35-1T, Power Supply: Corsair AX1000, Storage: 1TB Samsung 860 Pro (OS), 1TB Western Digital SN750 Black (Games), Cooling: Nzxt X79 360mm AIO, Operating system: Windows 10 Pro 1909 64-bit





*"The long period of total Nvidia dominance at the high end has come to an end. The 3080 is still a faster card, but not in every game."*

through. Perhaps an extra DisplayPort would have been nice? Both cards make use of twin 8-pin PCIe connectors. These are certainly preferable to the proprietary 12 pin connector used by Nvidia FE cards, and they're also placed in a friendlier spot for hiding the cables.

### Performance

Now let's talk about how they perform! As you can see in the benchmarks, the RTX 3080 generally has a lead over the 6800 XT, but not in every game. A couple of months ago when we were wowed by the 3080, we had considered the thought that AMD would struggle to compete at the high end ever again! The 6800 XT also uses less power, but not a whole lot less and don't forget that 16GB frame buffer vs the 10GB of the 3080 makes it a compelling option. 3080 Ti incoming?

What's just as interesting, if not more so is that the 6800 has a good lead over the RTX 3070 while being priced around the same

level. Which one you go for out of the two may depend on whether you must have ray tracing support (here's looking at you *Cyberpunk 2077*) or whether you want a bit of extra future proofing with the 16GB of memory on the RX 6800.

In addition to the premium look and feel of the 6800 and 6800XT coolers, both provide great thermal and acoustic performance. Both cards can hardly be heard over the sound of our AIO cooler and both are much quieter than the reference RX 5700 XT. The RX 6800 recorded one of the lowest load temperatures we've seen from a high end reference card. The XT was a bit hotter but that's not unexpected with its higher power draw. Speaking of power draw, the 6800 and XT recorded full system power draws of 393W and 446W respectively. This compares to the 383W and 465W for otherwise identical 3070 and 3080 systems. Not bad, but we still don't like the way GPU TDPs are trending upwards.

The new Radeon 6000-series GPU, affectionately known as 'Big Navi', because everything needs a nickname, even silicon integrated circuits.

### Time to buy?

At the time of writing, the availability of the cards is a major problem. Quotes from retailers indicates that stock issues of RX 6000 cards will persist well into 2021 (the same situation is occurring with Nvidia's RTX 30 series). The result is a poor launch no matter if it's due to COVID, component supply issues or even mining demand. There will be a lot of disappointed gamers this Christmas. It's not good enough.

The long period of total Nvidia dominance at the high end has come to an end. The 3080 is still a faster card, but not in every game. AMD also leads in terms of power efficiency and value for money. We'll need time to really digest things like ray tracing performance (across a wide range of titles) and AMD's Super Resolution DLSS competitor but at this point in time, traditional rasterising performance is still the true performance differentiator. At that, AMD is highly competitive once more. Once ray tracing becomes widely adopted, we'll start to give it a higher weighting in our overall analysis.

We feel that the 6800 XT is the better 6000 series card, not only for its extra performance, but its relative value at just \$100 more. You also get a better cooler. Both cards represent a phenomenal jump in performance for AMD. If its ray tracing performance and super resolution performance catch up to Nvidia, RX 6000 cards will become an even bigger threat to Nvidia's current market dominance. Radeon is back! Let's just hope that supply picks up. None of it matters if you can't buy one.

CHRIS SZEWCZYK

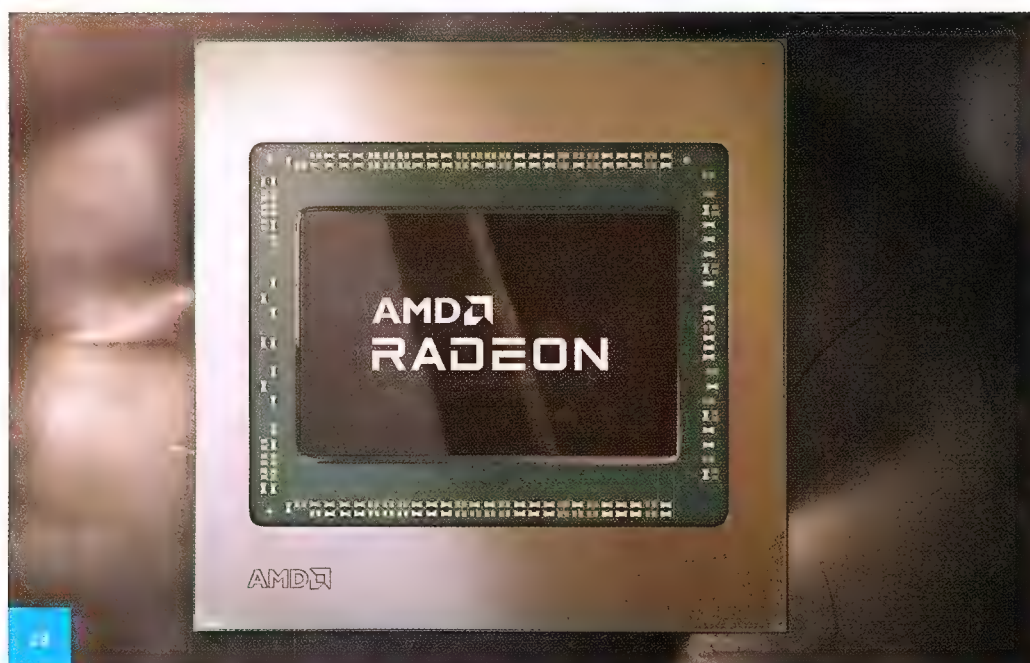
After many years of Nvidia dominance, AMD now has genuinely compelling high end options, that is if you're able to actually buy one.

**AMD 6800**

★★★★★

**AMD 6800 XT**

★★★★★







From \$999 | [microsoft.com](https://microsoft.com)

# Microsoft Surface Laptop Go

Microsoft's latest budget conscious Surface device pushes the envelope in price and performance to blur the line with premium laptops.

We weren't expecting Microsoft to release a Go variation of its Surface Laptop range in 2020, or ever really, but we're certainly glad it did. The original Surface Go and the Surface Go 2 have been dominating the best affordable/student laptops roundups for the last couple of years, so there'll be no shortage of people interested in this new more midrange clamshell.

While it might ditch the tablet form factor, the Surface Laptop Go has a 12.45 inch display that is still touchscreen and the unit feels super portable and compact, weighing in at 1.11kg. The resolution isn't quite FullHD at 1536 by 1024 pixels, but it maintains a pixel density of 148 PPI to look surprisingly good with the brightness cranked up.

Out of the box the Surface Laptop Go comes with the streamlined Windows 10S OS, but the various configurations are all running on an Intel Core i5-1035G1 processor, which is more than capable of handling full-fat Windows 10 Home. The range starts with models featuring 4GB of RAM and

64GB of eMMC storage for \$999, but we'd probably recommend upping this to a \$1,249, 8GB, 128GB SSD configuration for those looking to do anything more than browser-based work. If you're reluctant to move to a modern cloud-based workflow then you might want to expand that storage further to 256GB for a total of \$1,549, but this unit isn't the best value of the three.

The device comes with a reasonable modern offering of interface options with a USB Type-A socket, a USB Type-C interface, a 3.5mm audio jack and a SurfaceConnect charge port, so you won't get caught out connecting to older accessories. The keyboard isn't the best of the Surface range, but it's really nice for anything in this price bracket and the trackpad is responsive and easy to use.

The omnisonic speakers have been calibrated by Dolby and emanate through the chiclet keyboard, and there's a decent pair of far-field studio mics and a HD web camera which are more than enough to hold a clear web conference.

Testing of the 8GB, 256GB SSD variation revealed that the Surface Laptop Go's CPU is up to

**SPECS**  
Windows 10 Home (S mode);  
12.45-inch Pixel Sense display @ 1536 x 1024 pixel resolution (148PPI); Intel Core i5-1035G1 CPU; 8GB RAM; Intel UHD Graphics; Wi-Fi 6; 41Wh battery (4h 16min 1080p movie playback); 27.8 x 20.6 x 1.6cm; 1.1kg.

three and a half times faster than Intel Pentium processor on the Surface Go 2, with all benchmarks showing at least 60 percent better performance. Combine this with between 30 and 57 percent better graphical performance and you've got a similarly priced product that outperforms its predecessors considerably.

Despite its budget conscious approach the Surface Laptop Go even manages to throw in some premium perks like a fingerprint security reader and NVMe SSD read and write speeds of 2,000/800MB/s on the two more expensive units. Battery life is decent lasting six hours and 53 minutes in PCMark 10 Home Office battery tests and four hours 16 minutes in 1080p movie playback.

With Wi-Fi 6 and Bluetooth 5 compatibility, this device ticks almost all the boxes of a serious premium laptop yet comes in at the price of a budget-conscious student device.

JOEL BURGESS

Everything you could want in a premium laptop at one of the most competitive price points we've seen around.

★★★★★





\$899 | www.msi.com

# MSI GeForce RTX 3060 Ti Gaming X Trio

A more affordable Ampere.

Nvidia's RTX 30 series is further fleshed out with the release of the highly anticipated RTX 3060 Ti. While most of us lust over cards like the RTX 3080, we need to remember that they cost a lot in relative terms. Most gamers spend their hard earned dollars on cards a little more worldly. We have the MSI RTX 3060 Ti Gaming X Trio on hand for review. At \$899 it's not what we'd call a budget card, but if you're looking for a quality 1440p gaming GPU, the 3060 Ti might be just what you're looking for.

As an Ampere generation card,

of course you get plenty of next generation feature support including significantly improved ray tracing capabilities and DLSS. We're sure many gamers are looking forward to enjoying these features with games such as *Cyberpunk 2077* including full support.

The RTX 3060 Ti shares a lot in common with the RTX 3070. It uses the same 8nm GA104 GPU, albeit a cut down version. It contains 4,864 cores compared to the 5,888 of the RTX 3070. Common to the two is 8GB of 14Gbps GDDR6 memory over a

**SPECS**  
MSI GeForce RTX 3060 Ti Gaming X Trio; 4,864 Shader Units; 1,410MHz Base Clock, 1,830MHz Boost Clock; 8GB GDDR6 14Gbps memory, 448GB/s Memory Bandwidth; 3x Display Port 1.4, 1x HDMI 2.1; 2x 8-Pin Power Connectors, 240W TDP.

256bit bus. The MSI card we have on hand features a hefty factory overclock. Where a standard 3060 Ti features a boost clock of 1,665MHz, the MSI Gaming X increases that to a lofty 1,830MHz, though as we saw during testing, in reality it boosts much higher than this. The TDP is 240W, this is quite a bump up from the 200W of a Founders Edition card.

The MSI Gaming X features the company's massive triple fan Tri Frozr cooler, the same as the one that's found on its 3080 Gaming X. We know that it cools that card with ease, so its ability to cool a lower TDP card will be more than adequate. It's a triple slot card and it's long and tall as well so you'll need to make sure it will fit in your case. There's an RGB light bar along the side of the card and a full cover backplate. It's a monster of a card.

The card features a custom PCB with an 8-phase VRM that's directly cooled by the main heatsink. It's powered by a pair of 8-pin PCIe connectors. We're happy to see this as we're not convinced the proprietary 12-pin connector common to Nvidia FE cards really serves any purpose unless it becomes standardised. The card features a comprehensive set of display outputs including three DP 1.4 and a single HDMI 2.1 port.

When it comes to performance, the RTX 3060 Ti is faster than the 2080 Super and it destroys 2070

*"When it comes to performance, the RTX 3060 Ti is faster than the 2080 Super and it destroys 2070 and 2060 class cards. Only the 2080 Ti from the Turing generation is faster and we all remember how much that cost when it launched"*

|                                       | TEMPS °C |      | 3DMARK           |                     |
|---------------------------------------|----------|------|------------------|---------------------|
|                                       | IDLE     | LOAD | TIME SPY EXTREME | FIRE STRIKE EXTREME |
| AMD Radeon RX 6800                    | 42       | 66   | 7,226            | 19,956              |
| Nvidia GeForce RTX 3070 FE            | 32       | 73   | 6,756            | 16,378              |
| MSI GeForce RTX 3060 Ti Gaming X Trio | 39       | 66   | 6,174            | 14,514              |
| Nvidia GeForce RTX 2080 Ti            | 36       | 68   | 6,815            | 16,068              |
| Nvidia GeForce RTX 2080 Super         | 38       | 72   | 5,524            | 13,285              |
| Nvidia GeForce RTX 2060 Super         | 36       | 71   | 4,460            | 10,646              |
| AMD Radeon RX 5700 XT                 | 37       | 82   | 4,469            | 12,356              |

■ Best result  
■ On test



and 2060 class cards. Only the 2080 Ti from the Turing generation is faster and we all remember how much that cost when it launched, so it's great to see price/performance take a big leap forward. The massive cooler allows the card to maintain huge boost clocks. The MSI was always sitting in the mid 1,900MHz range whilst never hitting 70c. Very impressive indeed.

The MSI Gaming X is a monstrous card. It's overkill really for a mid-range class card but at least you'll know that temperatures and noise levels won't ever be a concern. It's hard to think of the 3060 Ti as a mid-range card, especially the premium tier MSI when it's priced at \$899 but such is the demand for graphics cards in 2020, it's unsurprising. The market sets the price, and people want them. A lot of them. The main problem for MSI is that its price is very near to the price of its own RTX 3070 cards,

*"The MSI Gaming X is a monstrous card. It's overkill really for a mid-range class card but at least you'll know that temperatures and noise levels won't ever be a concern."*

notably the Ventus. Going for one of those makes a lot of sense, but then 3070s are all but impossible to buy so it may be a moot point. MSI stated that it expects stocks of the 3060 Ti to be more plentiful than what we've seen with other RTX cards and also AMD RX 6000 cards. This alone is very welcome.

The 3060 Ti is a great 1440p card and if it proves to be widely available, it will be a very popular card, especially if you're playing games with ray tracing or DLSS support. It remains to be seen how AMD will react, but we know it's got a response in the works. If the pricing of lower tier 3060 Ti cards is able to drop a bit, which will truly bring it into the range of the mass market then we'd unequivocally recommend it. But the steep pricing will keep it out of reach of too many gamers for now. Pricing is flexible though and the market may yet have a few surprises to come.

CHRIS SZEWCZYK

The 3060 Ti and particularly the MSI flavour elevates mid-range GPU performance to a new level, but it comes at a price.

★★★★☆

Best result  
On test

|                                       | METRO: EXODUS                     |                                   |                                   |
|---------------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|
|                                       | 1920X1080 ULTRA<br>PRESET AVG FPS | 2560X1440 ULTRA<br>PRESET AVG FPS | 3840X2160 ULTRA<br>PRESET AVG FPS |
| AMD Radeon RX 6800                    | 107.3                             | 87.6                              | 55.3                              |
| Nvidia GeForce RTX 3070 FE            | 103.1                             | 81.4                              | 51.1                              |
| MSI GeForce RTX 3060 Ti Gaming X Trio | 89.0                              | 70.7                              | 44.7                              |
| Nvidia GeForce RTX 2080 Ti            | 108.6                             | 85.4                              | 54.1                              |
| Nvidia GeForce RTX 2080 Super         | 90.0                              | 71.6                              | 44.7                              |
| Nvidia GeForce RTX 2060 Super         | 66.6                              | 52.4                              | 32.4                              |
| AMD Radeon RX 5700 XT                 | 73.3                              | 57.7                              | 35.7                              |

|                                       | GHOST RECON: BREAKPOINT           |                                   |                                   |
|---------------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|
|                                       | 1920X1080 ULTRA<br>PRESET AVG FPS | 2560X1440 ULTRA<br>PRESET AVG FPS | 3840X2160 ULTRA<br>PRESET AVG FPS |
| AMD Radeon RX 6800                    | 122                               | 87                                | 60                                |
| Nvidia GeForce RTX 3070 FE            | 107                               | 86                                | 52                                |
| MSI GeForce RTX 3060 Ti Gaming X Trio | 100                               | 79                                | 47                                |
| Nvidia GeForce RTX 2080 Ti            | 107                               | 86                                | 56                                |
| Nvidia GeForce RTX 2080 Super         | 95                                | 74                                | 44                                |
| Nvidia GeForce RTX 2060 Super         | 78                                | 61                                | 35                                |
| AMD Radeon RX 5700 XT                 | 90                                | 67                                | 17                                |

|                                       | MIDDLE EARTH: SHADOW OF WAR       |                                   |                                   |
|---------------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|
|                                       | 1920X1080 ULTRA<br>PRESET AVG FPS | 2560X1440 ULTRA<br>PRESET AVG FPS | 3840X2160 ULTRA<br>PRESET AVG FPS |
| AMD Radeon RX 6800                    | 175                               | 132                               | 78                                |
| Nvidia GeForce RTX 3070 FE            | 161                               | 116                               | 71                                |
| MSI GeForce RTX 3060 Ti Gaming X Trio | 138                               | 100                               | 62                                |
| Nvidia GeForce RTX 2080 Ti            | 166                               | 121                               | 75                                |
| Nvidia GeForce RTX 2080 Super         | 137                               | 100                               | 61                                |
| Nvidia GeForce RTX 2060 Super         | 110                               | 78                                | 47                                |
| AMD Radeon RX 5700 XT                 | 116                               | 78                                | 47                                |

|                                       | TOTAL WAR: WARHAMMER II           |                                   |                                   |
|---------------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|
|                                       | 1920X1080 ULTRA<br>PRESET AVG FPS | 2560X1440 ULTRA<br>PRESET AVG FPS | 3840X2160 ULTRA<br>PRESET AVG FPS |
| AMD Radeon RX 6800                    | 139.3                             | 107.2                             | 58.4                              |
| Nvidia GeForce RTX 3070 FE            | 128.9                             | 97.9                              | 54.6                              |
| MSI GeForce RTX 3060 Ti Gaming X Trio | 116.5                             | 86.2                              | 49.5                              |
| Nvidia GeForce RTX 2080 Ti            | 136.8                             | 101.4                             | 56.5                              |
| Nvidia GeForce RTX 2080 Super         | 108.8                             | 79.6                              | 46.4                              |
| Nvidia GeForce RTX 2060 Super         | 88.7                              | 63.3                              | 34.7                              |
| AMD Radeon RX 5700 XT                 | 89.7                              | 61.9                              | 32.9                              |

|                                       | SHADOW OF THE TOMB RAIDER         |                                   |                                   |
|---------------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|
|                                       | 1920X1080 ULTRA<br>PRESET AVG FPS | 2560X1440 ULTRA<br>PRESET AVG FPS | 3840X2160 ULTRA<br>PRESET AVG FPS |
| AMD Radeon RX 6800                    | 175                               | 125                               | 68                                |
| Nvidia GeForce RTX 3070 FE            | 160                               | 114                               | 62                                |
| MSI GeForce RTX 3060 Ti Gaming X Trio | 143                               | 99                                | 54                                |
| Nvidia GeForce RTX 2080 Ti            | 164                               | 114                               | 63                                |
| Nvidia GeForce RTX 2080 Super         | 140                               | 96                                | 51                                |
| Nvidia GeForce RTX 2060 Super         | 108                               | 73                                | 38                                |
| AMD Radeon RX 5700 XT                 | 118                               | 79                                | 41                                |





\$2,299 | asus.com

## Asus ZenBook 14 UX435

Has Asus's new ZenBook 14 found inner peace, or is it distracted by finding the next big thing?

Asus has a flair for laptop innovation that's seen it do amazing things, like create compactable vents on its first Max-Q gaming laptops, build our favourite premium laptop using a new AMD Ryzen processor, and create an awesomely productive second screen on its Zephyrus Duo units – but occasionally it gets things wrong... and we kinda wish it'd let these things die.

In this particular instance we're talking about the ScreenPad touchscreen trackpad, which, while still better on the UX435 than it has ever been previously, still manages to detract significantly from the overall experience. Whether it is the limited set of custom-built applications, the almost-useable but still janky interface, or the fact that it prioritises apps and second display functionality over being a usable trackpad the ScreenPad has a lot of major pitfalls. And since it can't really do things above what

your smartphone can, it's also lacking any real redeeming features. Fortunately a function button turns it back into a trackpad, so it's not a dealbreaker.

Apart from this the new ZenBook 14 UX435 is actually a pretty amazing unit. The range features one of Intel's new 11th Gen processors and the Intel Iris Xe GPU accompanies this processor. The UX435 also has a discrete Nvidia GeForce MX450 GPU and offers eight or 16GB of RAM. Intel's Iris Xe graphics are actually capable of entry level 1080p gaming, so we were a little worried that the additional MX430 would be redundant if it didn't offer better gaming performance, but fortunately it was 47 percent better in OpenCL benchmarks and offered between 40 and 86 percent faster frame rates across all the games we tested. This means it was able to get 50fps+ fps on games like *The Division 2* and *Civilization VI* on

'Low' 1080p settings and can even run playable frame rates with Ultra 1080p settings on *F1* and anything else that's a little more lightweight.

In addition to being a pretty great entry gaming device, the UX435 is a solid work machine too. We tested the Core i7-1165G7 model with 16GB of RAM, which will chew through everything but the most demanding technical software. It even managed to outperform Dell's XPS 13 in a handful of work benchmarks, which leads us to suspect that even the Core i5-1135G7 variation will be enough for most people's workflows.

Unfortunately, Asus hasn't done a lot of efficiency optimisation on the UX435, which lasts only three hours and 31 minutes in PCMark 10's Home Office battery benchmark. That's quite a bit less than the XPS 13's eight hours and 51 minutes.

1080p is more than enough for a 14-inch screen, but when the competition is offering 4K HDR screens, this 300nit FullHD display looks a little dull. SSD speeds are great at around 3,000MB read and write and the CPU seems to have a better cooling system than the XPS 13, hitting a max of 95 degrees throughout testing.

JOEL BURGESS

A well rounded flagship laptop for those happy to sacrifice screen quality and battery life for a decent gaming performance bump.

★★★★★

■ Best result  
■ On test

|                                             | ASUS ZenBook 14 UX435 | Dell XPS 13 late 2020 (9310) |
|---------------------------------------------|-----------------------|------------------------------|
| PCMark 10 - Overall (score)                 | 5,077                 | 4564                         |
| Cinebench R20 - CPU (multi-threaded)        | 1,591                 | 2,053                        |
| Geekbench 5 - Multi-core (score)            | 5,022                 | 3,428                        |
| 3DMark Fire Strike (score)                  | 4,275                 | 4,498                        |
| Battery life - 1080p video playback (h:min) | 04:51                 | 07:00                        |
| Peak CPU temperature (°C)                   | 95                    | 100                          |
| CrystalDiskMark Read (MB/s)                 | 3,469                 | 3,165.8                      |
| CrystalDiskMark Write (MB/s)                | 2,751                 | 3,069.1                      |





\$1,500 | [www.synology.com/en-au](http://www.synology.com/en-au)

# Synology DiskStation DS1621+

Who should be buying Synology's latest six-bay NAS?

Synology's DS1621+ is an SMB-oriented, six-bay NAS that's an update to the DS1618+. The six bays are easily accessible for hot-swapping hard drives and can be locked to avoid pilfering passers-by. Setting up is simple: you just need to insert your drives, connect to a network and then run Synology's 'NAS finding tool' – either on a PC or mobile. From there you can choose the RAID configuration that best suits your performance, capacity and redundancy requirements.

The DSM operating system hasn't changed much over the years and it's all the better for it. With so many media and storage management systems coming and going over the years (the latest being Google Photos) it's great to know that Synology's ecosystem only evolves over time: adding new features, reliability, and performance tweaks to core applications that have been around for years. This helps make Synology a stalwart option for consumers, IT enthusiasts, demanding office managers, media workers, and developers alike.

If the six drive bays ever feel restrictive(!) the two eSATA ports at the rear can connect to

two more five-bay Synology expansion units. This is somewhat overkill for domestic users.

A core difference over its predecessor is the move to a Ryzen processor. It's not more powerful than its Intel counterpart but it's more power efficient. There are two M.2 drive bays which can be used for caching and space for up to 32GB of ECC RAM. This is all particularly useful for those wanting to run Virtual Machines and coding environments on the device. Four Gigabit Ethernet ports are included which may still feel limiting when multiple people are accessing large files and processes. They can be configured to act as one 400+ Mbps interface but those wanting office-grade network connectivity may prefer making use of the x8 PCIe slot, which can host a networking card that caters for dual 10GbE connections.

Other connectivity includes a USB 3.0 port at the front plus two more at the back. Beyond all this, it's the usual NAS box that we've grown used to from Synology. Two large fans cool it from the rear but they maintain a quiet, non-invasive whooshing sound most of the time: any annoying

**SPECS**  
2.2GHz quad-core  
Ryzen V1500B  
CPU, 4GB DDR4  
ECC RAM  
(expandable to  
32GB), 6 x  
lockable 3.5-inch  
drive bays, 2 x  
NVMe M.2 2080  
drive bays, 2 x  
eSATA, 3 x USB  
3.0, 4 x 1Gb  
Ethernet ports,  
PCIe x8 slot,  
Synology  
DiskStation  
Manager  
operating system.

noises tend to come from using cheap hard drives.

But it's the software that really makes Synology so attractive. It's not just the impressive library of perpetual-licence, Synology-made backup, surveillance, coding, multimedia management, office application, mail and messaging, web hosting and professional media storage and management apps, there's the vast array of third-party apps including the likes of PLEX and WordPress – that are also easy to use.

At \$1,500 it's more suited to an SMB than domestic setting, but some IT enthusiasts may want one for themselves. Its expansion options mean it's a sound investment that should last into the future without feeling limited – very impressive for technology nowadays. Those who already own the \$300-cheaper DS1618+ won't need to upgrade, but this is a great price vs. performance sweet spot that will prove attractive to many.

NICK ROSS

A great combination of performance, capacity, features, expandability and price point for any SMB.

★★★★★





\$2,049 | [www.draytek.com.au](http://www.draytek.com.au)

## DrayTek VigorSwitch P2540x

A feature-rich PoE switch with comprehensive management options.

The rack-mountable DrayTek VigorSwitch P2540x stands out with a massive 54 ports all up, and a very competitive \$2,049.95 RRP. Of the ports, 48 are Gigabit Ethernet (supporting eight link aggregation groups) with PoE of up to 30W each. Our only niggle is that it's limited to 400W overall (8W per port), meaning that it is possible to run out of power before running out of ports. It then has six 10GbE SFP+ slots for high speed connections.

While overkill for many smaller businesses, the P2540x is well equipped for those medium or larger size enterprises with substantial networking needs. Key uses might be running a security camera array, a VOIP phone system, data services or linking in remote sections of larger premises. Importantly, the six SFP+ connections support optic fibres, rather than copper cables, and offer lower latency, better efficiency and much longer ranges at full speed. It is also possible to use SPF+ modules (costing around \$100) that use standard ethernet cabling, for support of existing 10GbE devices such as NAS. So in other words, the P2540x is well equipped to be the core switch in a robust

network for a growing business.

The P2540x pairs the hardware with a comprehensive software feature set – and more than we can cover here. The highlights include Power over Ethernet control with on/off scheduling and the ability to remote power cycle a device if it goes offline. The switch automatically detects IP camera and phone traffic, tags it for quality of service, and for ONIF devices, displays the topology and even allows image viewing. You can create 256 VLANs, automatically avoid IP conflicts or reserve addresses, have multiple admin accounts, create access control limitations and manage your network security.

To get hands on with the inbuilt network management options, we tested the P2540x with a range of DrayTek access points and routers, plus a bundle of IP cameras. Be aware the fans can get a touch noisy so it's best set up in a dedicated area. The dense but comprehensive web interface is fast and easy to use for overall control, but lacks some advanced features for controlling remote network devices. DrayTek also provides the free VigorConnect software, and while it isn't quite



**SPECS**  
48x RJ-45 1GbE  
LAN Ports; 6x  
10GbE SFP+  
slots; PoE: 30W  
per port, 400W  
total  
Switching  
Capacity: 216  
Gbps; VLANs:  
256; 19" Rack  
Mountable 441mm  
x 330mm x 45mm  
Weight: 5.66 KG.

as seamless as we'd like, it does make managing multiple devices from the one interface easier.

The more advanced business-focused option is the paid VigorACS 2. The cloud based management is quite advanced (and aimed at your IT staff), and takes a bit of work to get set up correctly. That said, it provides extremely comprehensive remote management, real time monitoring, automatic provisioning, backup, update and data logging options. Every Vigor device comes with a 30 day free trial, (and there's an online demo on the DrayTek website at [www.draytek.com.au/products/network-management-tools/vigoracs-2](http://www.draytek.com.au/products/network-management-tools/vigoracs-2)) but the full version is a paid subscription starting at \$349.95 a year for 25 nodes. While that sounds steep, the time savings alone make it more than worth the price for larger businesses.

LINDSAY HANDMER

The VigorSwitch P2540x is an excellent choice for businesses needing comprehensive PoE networking and SFP+ speeds, backed up by powerful management options.

★★★★★





*“What you get out of it will depend greatly on your existing expertise in security and your propensity for getting stuck in to a configuration environment that can be simultaneously simple and perplexing.”*



\$79 | [www.yubico.com](http://www.yubico.com)

## Yubico YubiKey 5C NFC

A robust security key for both physical and software applications. But, who's the target market?

Cybercrime was rocketing long before COVID threw napalm on the bonfire. If you think that's hyperbole just enter your email address at [www.haveibeenpwnd.com](http://www.haveibeenpwnd.com) and have your password history regurgitated along with the surprising sources of who got hacked and spilled your details. Locking down your passwords and accounts has never been more important and, to this end, Yubico's latest YubiKey 5C NFC security key seeks to add an extra layer of security to all of your computer, mobile, application and web operations.

YubiKeys have been around for over ten years. This latest model is notable for its USB Type-C connector and NFC connectivity plus a touch-sensitive button.

It's not particularly cheap at around \$80. Trays of 10 or 50 devices come with just a four percent discount. The latter is so that IT departments can roll them out to staff which, Yubico tells us, is a great way to secure work computers and applications while reducing support costs. In this respect it'll likely represent a plug'n'play device that's a corporate tool. However, individual users can make great

use of it too, although what you get out of it will depend greatly on your existing expertise in security and your propensity for getting stuck in to a configuration environment that can be simultaneously simple and perplexing.

The marketing blurb is illustrative, “The YubiKey offers superior security by combining hardware-based authentication and public key cryptography to effectively defend against phishing attacks and eliminate account takeovers. It offers multi-protocol support including FIDO2, Yubico OTP, OATH HOTP, U2F, PIV, and Open PGP. Users have the broadest options for strong authentication including not only two-factor authentication, but also support for single factor passwordless login and multi-factor authentication in conjunction with user touch and PIN.”

Chances are, you've heard of some of those terms before but not necessarily in a security context. In reality, it operates in a variety of different situations which may or may not resonate with your day-to-day computing experience. At its most basic level, it can be used like a SmartCard to enable simple-but-secure log-on to a computer – but it doesn't natively

**SPECS**  
Multi-protocol support for WebAuthn, FIDO2, FIDO U2F, smart card (PIV), Yubico OTP, OpenPGP, OATH-TOTP, OATH-HOTP and Challenge-Response. USB Type-C, NFC.

unlock Windows 10 (you'll need to use additional authentication). It can also secure a password manager to ensure that, should your master password be cracked, a cyber-baddie still won't be able to access your other passwords.

It can be linked with a Yubico mobile app (in partnership with other mobile authenticators) plus many other things that hardened security experts already know about. Yubico also works with many major third-party entities and instructions are provided for how to set-up all of them – although they're not always clear. In practice some access becomes simple while with others, you wonder if all the setting up is worth the hassle. If you ever lose the tiny device you'd better have the documentation for account recovery stored somewhere else... securely(!)

Ultimately, it feels more like a device for corporates and power users but ordinary users who are particularly security-conscious can benefit too. It's a bit overkill for casual users.

NICK ROSS

A potential god-send to hardened security buffs who tire of repetitive and unsecure logins. But overkill for casual users.

★★★★☆





\$110 (base unit), \$152 (kit) | [www.raspberrypi.org](http://www.raspberrypi.org)

## Raspberry Pi 400

Taking a leaf out of 80s computer design, the Raspberry Pi Foundation has put its latest Raspberry Pi inside a keyboard.

The Raspberry Pi Model B has had the same board layout since the Raspberry Pi B+ arrived in 2014.

Sure, the Raspberry Pi 4 swapped the Ethernet and USB ports around, but the basic design has persisted. So when we received a parcel from Raspberry Pi Trading and opened the box to find a white keyboard, we were somewhat puzzled as to the contents. But not for long. Within this compact and well-designed keyboard is a Raspberry Pi 400, a variant of the Raspberry Pi 4 4GB that's been designed specifically to make the most of its new surroundings.

The device is being sold as a single unit for \$110 or as a \$152 kit with mouse, power supply, cables, micro SD card and a copy of The Official Raspberry Pi Beginner's Guide. Either way, the Raspberry Pi 400 could be the ideal way to introduce the Raspberry Pi to your home.

### Meet the Rasptrum

If you're of a certain age then you'll remember a time where computers were hidden underneath a keyboard. The Raspberry Pi 400 brings that aesthetic back and it works rather well. The compact keyboard

measures just over 11x4.6x0.7 inches (283x120x20mm) and is fairly comfortable to type on. We won't be writing our next thesis with this keyboard, but it's fine for daily use.

At the rear of the keyboard are all of the ports, the largest of which is a 40-pin header for the GPIO. Moving along we find a micro SD card slot, two micro HDMI ports that offer 4K output, two USB 3.0 ports and a single USB 2.0 port, with a Gigabit Ethernet port rounding off the Raspberry Pi 400's range of inputs.

Despite the change in form factor, this is still a Raspberry Pi 4 4GB and as such it behaves in much the same manner. There are a few differences, though. The Raspberry Pi 400 lacks the CSI and DSI connectors that are used for the Camera and Official Touchscreen. Without these connectors there's no way to use those devices. This loss of the touchscreen connector isn't such a big deal, but the same can't be said about the loss of the camera connector. The Raspberry Pi cameras are cheap and effective add-ons that provide a fun stream of projects. Essentially, if you want to create camera projects,

#### SPECS

CPU: 1.8GHz  
64-bit quad-core  
Arm Cortex-A72  
CPU (ARM v8,  
BCM2711)  
Mem: 4GB LPDDR4  
Comms: Wi-Fi  
dual-band 802.11  
b/g/n/ac;  
Bluetooth 5.0; BLE  
Ports: 2 x USB  
3.0; 1 x USB 2.0;  
gigabit Ethernet;  
40-pin GPIO;  
2 x micro-HDMI  
(4Kp60)  
Video: H.265  
(4Kp60); H.264  
(1080p60,  
1080p30 encode);  
OpenGL ES 3.0  
HDD: microSD  
card  
Power: USB-C  
Size: 283x120  
x20mm.

then the Raspberry Pi 400 isn't for you.

Accessing the GPIO is relatively easy. You can use jumper wires to make connections to a breadboard, but connecting a HAT or pHAT isn't possible without a breakout board such as Pimoroni's HAT Hacker HAT. We understand why this had to be the only way to break out the GPIO, but it remains an obstacle for GPIO projects. With a breakout connected we quickly attached an Explorer HAT Pro to test compatibility and everything worked as expected.

The Raspberry Pi 400 shares the ability to boot from USB. We attached an NVMe drive containing Ubuntu 20.10 via USB3 and the Pi 400 booted directly from it. There were no issues and our experience was pretty slick.

■ Best result  
■ On test

|                                            | IDLE TEMPERATURE<br>(°C) | SYSBENCH<br>TEMPERATURE<br>(°C) |
|--------------------------------------------|--------------------------|---------------------------------|
| RASPBERRY PI 4<br>STOCK                    | 40                       | 65                              |
| Overclocked to 1.9GHz<br>with 100MHz Vcore | 31                       | 45                              |
| Overclocked to 1.9GHz<br>with 100MHz Vcore | 32                       | 54                              |
| Overclocked to 1.9GHz<br>with 100MHz Vcore | 34                       | 57                              |



## Hey there, hot stuff

At its heart, the Raspberry Pi 400 is a Raspberry Pi 4 and it's well known that the Pi 4 can become rather warm in use. In general use the CPU will stay cool enough to remain well under the thermal throttle limit of 85°C, but overclockers eager to squeeze extra performance from the CPU will often push those limits. The stock speed of the Pi 400 is 1.8GHz. That's 300MHz more than the standard Raspberry Pi 4 and so it's surprising that the idle temperature of the Pi 400 is 31°C, compared to our "control" Raspberry Pi 4 which was at 40°C.

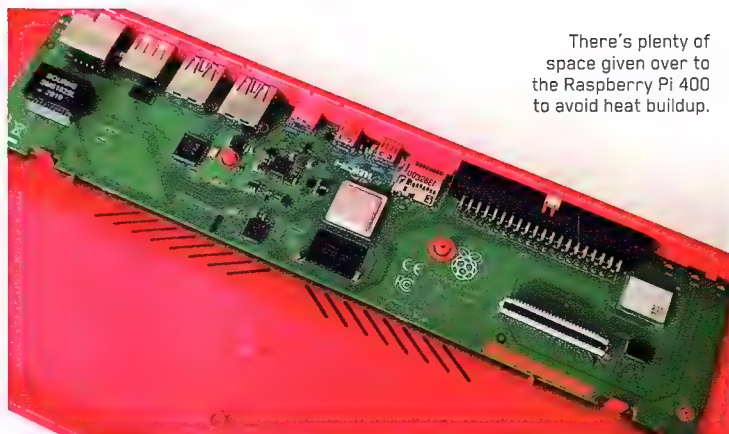
During our Stressberry test we saw the Pi 400 reach a peak of 46°C. That's almost 20°C lower than a stock Raspberry Pi 4! We wanted to push the Raspberry Pi 400 a little harder and so we overclocked to 2.1GHz and repeated the tests. The idle temperature remained a cool 32°C, with a peak of 54°C during Stressberry. These temperatures are great, so we wondered if we could push things a little further? We went for 2.2GHz because it was the highest stable overclock that we could achieve. This resulted in an idle temperature of 34°C and a peak Stressberry temperature of 57°C.

## Keeping cool under pressure

How can the Raspberry Pi 400 run at 1.8GHz and yet remain so cool? We asked that question to Eben Upton, chief executive of Raspberry Pi Trading. "We're able to operate at a higher voltage, and thus generate more heat, because we have a more sophisticated thermal solution. So we took the decision to factory-qualify Pi 400 to the higher operating frequency. It's a unique capability for the Pi 400."

With this news spurring us on we quickly took the Raspberry Pi 400 apart and first noticed an exceptionally large heatsink. This acts as a 'shield' between the keyboard and the Pi 400 board, with a depression and thermal pad making contact with the system on chip (SoC). This heatsink is remarkable and largely responsible for the great temperatures and overclocking potential of the Raspberry Pi 400.

We asked Eben to explain why the Raspberry Pi 400 was created. "The next step in our mission is to provide cost-effective, high-performance, general-purpose PCs to everyone who needs/wants one," he said. "This form factor was very popular for non-mobile computers in the



There's plenty of space given over to the Raspberry Pi 400 to avoid heat buildup.



The Raspberry Pi 400 comes with plenty of ports, but CSI and DSI connectors aren't among them.



That exciting-looking red piece is just a keyboard support pillar. So, not exciting at all.

past, and we've drifted away from it, in much the same way that we drifted away from programmable computers. So this is a conviction product just like the Raspberry Pi itself: there's a latent demand for this sort of compact PC."

What does that mean for potential use cases? This is a Pi for learning. In a similar vein to 1980s home computers, it's a machine that we can simply connect to a television and a power source, then start learning to code. The Raspberry Pi 400 can also be used as a basic desktop computer and is more than capable of handling your general activities.

While a departure from the

usual pared-back Pi experience, the Raspberry Pi 400 is a great all-rounder. We get the same Raspberry Pi experience, but with far fewer wires and setup. As a package the Raspberry Pi 400 is an ideal present for someone taking their first steps in coding. The awkward GPIO access and lack of camera and display ports are the only negatives for the Raspberry Pi 400. All in all, it's the ideal Raspberry Pi for those new to the community. **LES POUNDER**

A superb introduction to Pi computing, the Raspberry Pi 400 is a great way to enjoy a slice of Raspberry Pi.

★★★★★





\$999 | [store.google.com](https://store.google.com)

# Google Pixel 5

A streamlined 5G flagship with firepower where it counts.

The Google Pixel 5 is boldly bucking a trend in the smartphone market that this journalist would be very happy to see vanish entirely – the four-figure flagship. Google hasn't necessarily solved this issue, but it does seem to have taken a very solid step in the right direction with this year's lineup. The Pixel 5 is one of three handsets Google dropped on us in 2020 – the other two being the mid-range Pixel 4a and 4a 5G. There's no Pixel 5 XL in sight, instead the regular '5' has been given the premium treatment where it matters and had the luxurious fat trimmed to keep it (just) under \$1,000.

The first of the trimmings is a Snapdragon 765G running the show, rather than the top-shelf 865 found in Pixel's competitors. In practice, we certainly didn't notice any stutter or slowdown in day-to-day activities, watching videos or even gaming,

although if you're really serious about the latter, you'll likely be looking at a different device anyway. This breeziness is in part thanks to its 8GB of RAM, but is also helped by the handset sporting a display that isn't quite as top-spec as some of its Android alternatives. While the Galaxy S20 from Samsung features a 1440x3200 resolution and 120Hz refresh rate, the Pixel 5's display is 1080x2340 at 90Hz, which might not suit those looking for competitive mobile gaming but is still certainly far from shabby, even in today's market. It performs beautifully at every task thrown its way, with vivid colours, solid contrast and brightness, and smooth operation.

This handset sizing is another area that Google has opted to veer away from standard procedure, with the most expensive Pixel in the range actually being physically smaller and even having a slightly smaller screen

**SPECS**  
Qualcomm  
Snapdragon  
765G; Android 11;  
6-inch OLED  
display  
(1080x2340 @  
90Hz); Adreno  
620; 128GB  
storage; 8GB  
RAM; 12.2MP wide  
+ 16MP ultrawide  
primary cameras,  
8MP wide front  
camera; IP68  
rating; 4,080mAh  
battery with  
wireless +  
reverse-wireless  
charging;  
144.7x70.4x8mm;  
151g.

than it's more affordable 4a 5G sibling (\$799). At 145mm tall, 70mm wide, and 8mm thin, the Pixel 5 feels right at home in the palm, and its 151g of heft neither feels cheap nor cumbersome. We've seen Apple offer up the relatively compact 2020 iteration of the iPhone SE and now the iPhone 12 Mini, so it's clear there's a market for current and capable phones that don't encroach on tablet territory. At some point, the term 'phablet' was dropped from common parlance as the oversized smartphone became the rule rather than the exception, so it's good to see that steady screen growth reigned in.

Adding to its comfort in the hand is Google's choice to forego the usual glass-backed affair of most premium smartphones and return to aluminium. This metal chassis is a single molded piece that covers the back and wraps around the sides, only making way for the very slight camera bump, fingerprint scanner and side buttons. It seems rugged and durable, considerably moreso than glass, and offers a powerful IP68 dust- and water-resistance rating. It's gently textured, giving a hint of roughness for grip but managing to maintain a premium

*"While the Galaxy S20 from Samsung features a 1440x3200 resolution and 120Hz refresh rate, the Pixel 5's display is 1080x2340 at 90Hz, which might not suit those looking for competitive mobile gaming but is still certainly far from shabby, even in today's market."*



hand-feel, and is available in an understated Just Black or a unique Sorta Sage. The aluminium used in the Pixel 5 is 100% recycled too, which is part of the tech giant's commitment to have every single 'Made by Google' product include recycled materials by 2022. One of the primary reasons that manufacturers opted for a glass back (outside of its perceived premium sheen) was to allow for wirelessly charging the device, but the Pixel 5 gets around this. Not only can it be charged wirelessly, it's also able to reverse-charge other Qi compatible devices when rested on the back of the phone. If it had last year's rather small battery, this wouldn't be all that helpful, but thankfully the Pixel 5 is sporting an impressive 4,080mAh battery that well and truly gets you through a day of regular use – even two if you're being frugal. The large battery capacity is helped even further by the aforementioned display not being too power hungry, but also by the inherent efficiency of the Snapdragon 765G and its integrated 5G modem. Did we mention that it's 5G-ready?

As always, the camera performance from Google's hardware and software duality is top-notch. Using a combination of a 12.2MP wide and 16MP ultrawide primary camera, this handset takes stunning photos and captures awesome video. Alongside all the software and editing options Pixel users have come to love, you'll also have access to new features like the ability to adjust portrait lighting after a photo's been taken or to use the powerful Night Sight mode and background-blurring Portrait mode simultaneously. You'll also be able to capture 4K video at 60fps, allowing for smooth footage or slow-mo if you fancy. It's not all progress though, the telephoto lens found on the Pixel 5's predecessors is gone here, and while Google has accommodated for this with some clever software, it's certainly not as capable as dedicated hardware. With that said, the introduction of an ultrawide lens is arguably more useful for most phone photography needs, allowing



*"As always, the camera performance from Google's hardware and software duality is top-notch. Using a combination of a 12.2MP wide and 16MP ultrawide primary camera, this handset takes stunning photos and captures awesome video."*



users to capture group shots and landscapes with ease.

Along with the telephoto camera, another abandoned feature is the incorporation of Project Soli – Google's motion sensing technology. This is much less of a loss. When we tested this tech in the Pixel 4, we found it to be limited in scope and more of a novelty than a boon, so we disabled it fairly quickly. Soli's radar technology also allowed for some fairly advanced face ID capabilities, but honestly we're pleased with the return of a fingerprint scanner in its stead, offering a more tried and true measure of security.

The Google Pixel 5 is a simple phone, inside and out, but we're celebrating this fact. With its latest flagship, Google has offered up a powerfully smooth experience at an appropriate cost,

providing users with top-of-the-line performance in the areas that are truly core to a modern smartphone. For those seeking a portable media powerhouse or a compact gaming console, there are plenty of mightier options on the market with better displays, but they'll cost a good whack more. If you're attracted by the sweet camera, Google smarts, and 5G capabilities but don't mind a plastic shell and a few other absent features, the Pixel 4a 5G presents a great alternative for \$200 less.

HARRY DOMANSKI

A handset that exemplifies Google's shift away from super-premium smartphones, to 'affordable' models that punch above their price-point.

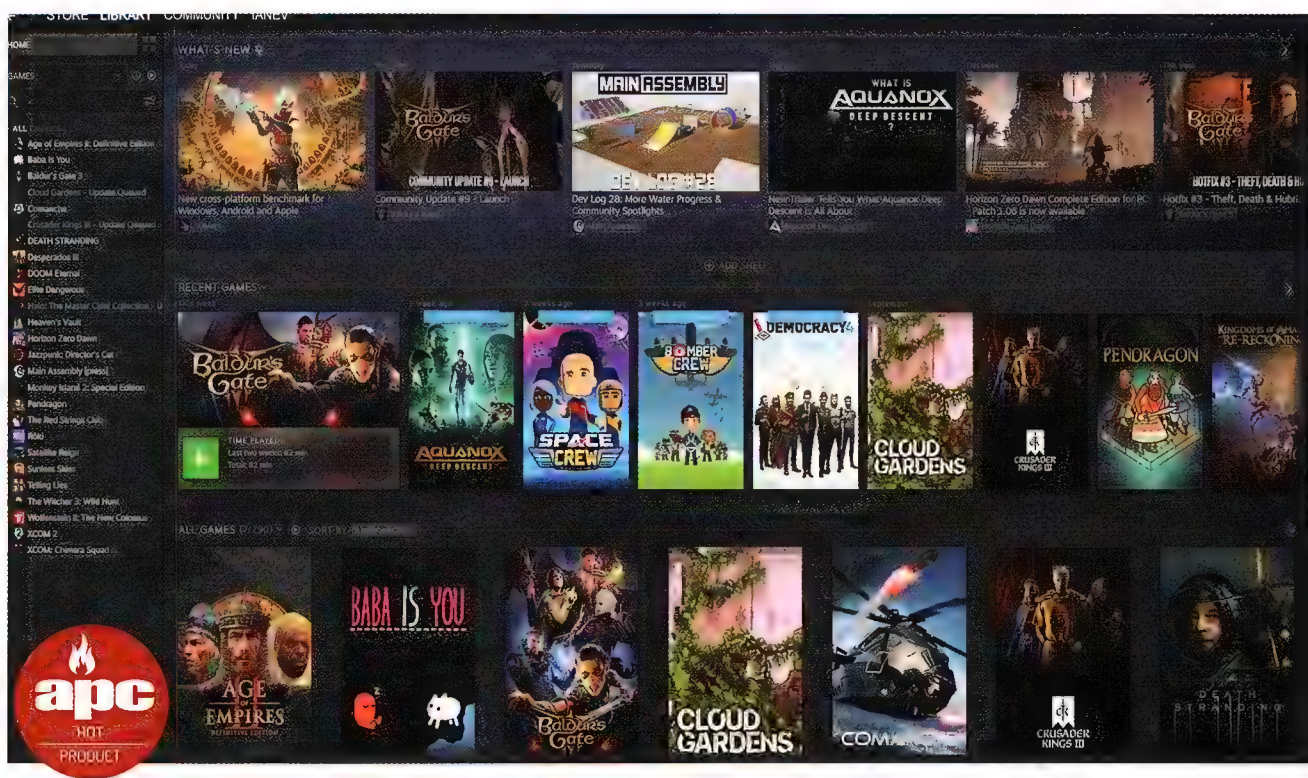
★★★★★





# SOFTWARE

APPS FOR ALL YOUR PLATFORMS



WINDOWS

Steam | Free | [store.steampowered.com](https://store.steampowered.com) Epic | Free | [www.epicgames.com/store](https://www.epicgames.com/store)

## Steam vs Epic Games Store

Digital storefronts battle it out for your money.

From its launch in 2003, Valve's Steam digital game store has had things pretty much its own way. In 2013 it held 75 percent of the market, and in 2017 represented 18 percent of global PC game sales. In 2019 it had 95 million active monthly users. It has branched out into game controllers, gaming boxes and even an operating system. If there was ever any doubt that PC gaming is huge, then Steam is all the evidence you need.

There have been competitors, of course. Who remembers Games For Windows Live? They have tended to be single-publisher stores, however, such as Ubisoft's Uplay and EA's Origin. It wasn't until 2012 that it got competition, when GOG – a previously retro-only store operated by *Witcher* developer CD Projekt – began selling more recent titles. Then, in December 2018, the Epic Games Store followed *Fortnite* by moving in on the game store scene.

Epic brought with it one simple promise that made it attractive to gamers: Free games. Not

free-to-play games like *Fortnite*, but paid-for titles, given away for free. This program began in 2019, and there's generally one or two a month, depending on the games' age ratings – if the main title shuts out younger players, another will be made available alongside it with lower requirements – rolling over on a Thursday. They range from tiny indie offerings such as *Abzu* or *Into The Breach* all the way up to *Grand Theft Auto V* or the *Batman Arkham* games. The free games have kept coming throughout 2020, though there's no evidence they will continue to do so perpetually.

Both stores are free to download, so there's no problem with having both apps installed on your PC. Some developers choose to sign exclusivity agreements, the first of which on Epic was *Metro: Exodus* from 4A Games. That title has since appeared on Steam, but others have taken its place, such as Creative Assembly with *Total War Saga: Troy*. This game was released for free on the Epic

With plenty of features and a huge selection of games, Steam is still the main player in the PC games store world.

Games Store for one day, before reverting to full price. It is listed as “coming 2021” on Steam, but with no further details. For other titles, prices may be different across storefronts, and it's always worth checking a publisher's store as well in case one of the outlets is having a sale on a title you particularly want.

If it's a niche title you're after, then Steam is your best bet. Its catalog of over 34,000 games (2019 figures) means it will almost certainly have what you're looking for. Epic's offering is a little more streamlined, although it gets wider every day. This means that Steam is a little better for discovery – Epic's “browse” mode allows you to narrow down the games or view by genre, plus features such as co-op or controller support, but Steam has all this and more besides, with tags, wishlists, curated lists of games from users, and lists of top sellers in each category. There are algorithmic recommendations



too, based on the games you've already got in your library, and you can leave a review if you fancy writing one. Steam also sells physical gift cards, if you're looking for a present for the PC gamer in your life as the holiday season approaches.

Community features also tend to be stronger on Steam. Epic's system offers to import your friends list from Facebook and Steam. There's a text chat system too, but little more. Steam, on the other hand, not only pulls in news from the internet to display on each game's storefront, but allows sharing of screenshots and in-game videos, group chat, and breakdowns of each game's social features. Then there are achievements, a metagame that puts players in direct competition with each other to see how many they can win and how quickly. All major console platforms have these, and it's good to see the little popup in the corner of the screen when you win one. They're also perfectly possible to ignore completely. Then there's the Steam Workshop, full of user-generated content. Epic is much newer, of course, and may well have features such as these in development.

## The other side

But while Steam might be a nicer place for gamers to hang out, it

The Epic Games Store lacks some of the features Steam offers, but its expanding store and regular freebies make it an attractive option.

looks a little different from the other side. Both stores take a cut of developers' income from any games sold. Steam takes a flat 30 percent for the privilege of using its storefront – the same rate Apple charges developers on its App Store – which then drops if a game sells more than 10 million copies. Steam's policy in this area has attracted criticism in the past, as it has not wavered as the cost of network delivery has become cheaper. Epic, having initially postulated that its commission could be as low as eight percent, takes a cut of 12 percent, with further discounts for games created using the Unreal Engine, which is also owned by Epic. Figures from market intelligence company NewZoo suggest that PC gaming is worth \$45 billion annually, and even if Steam's 75 percent share of digital downloads has been eroded by canny competitors such as Epic, that commission is enough to make big money for the distributor.

From a player's point of view, it's worth going to whichever storefront is offering the game you want for the lowest price. If online multiplayer is important to you, then go where the community, or your friends, are playing. Both stores are equally efficient at delivering patches, and on residential broadband

connections there's no difference in the speed at which things download – although anecdotal data on the internet suggests that Epic has the edge on fast broadband lines. The specs we list below are for running the client app itself; each game will have its own list of computer specs needed to run, often climbing into "dream machine" territory – although remember that many games will run perfectly well on mid-grade hardware at 1080p and medium settings.

What Epic is doing, however, is similar to what AMD recently did to Intel. A bit of competition in the marketplace does wonders for a firm's ability to update its products, and anything that incites Valve to improve what's already a very good product can only be a good thing for players. IAN EVENDEN

### Steam

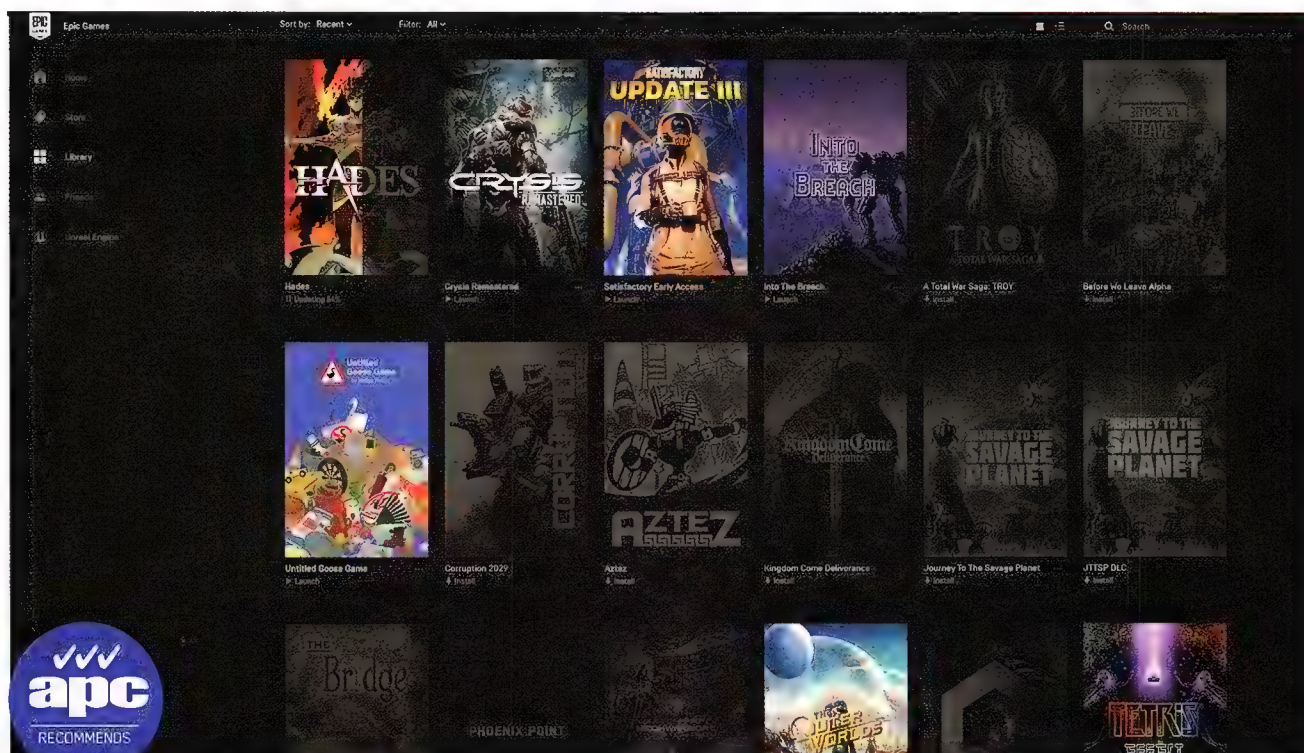
Enormous catalog; great community features; user-generated Workshop.

★★★★★

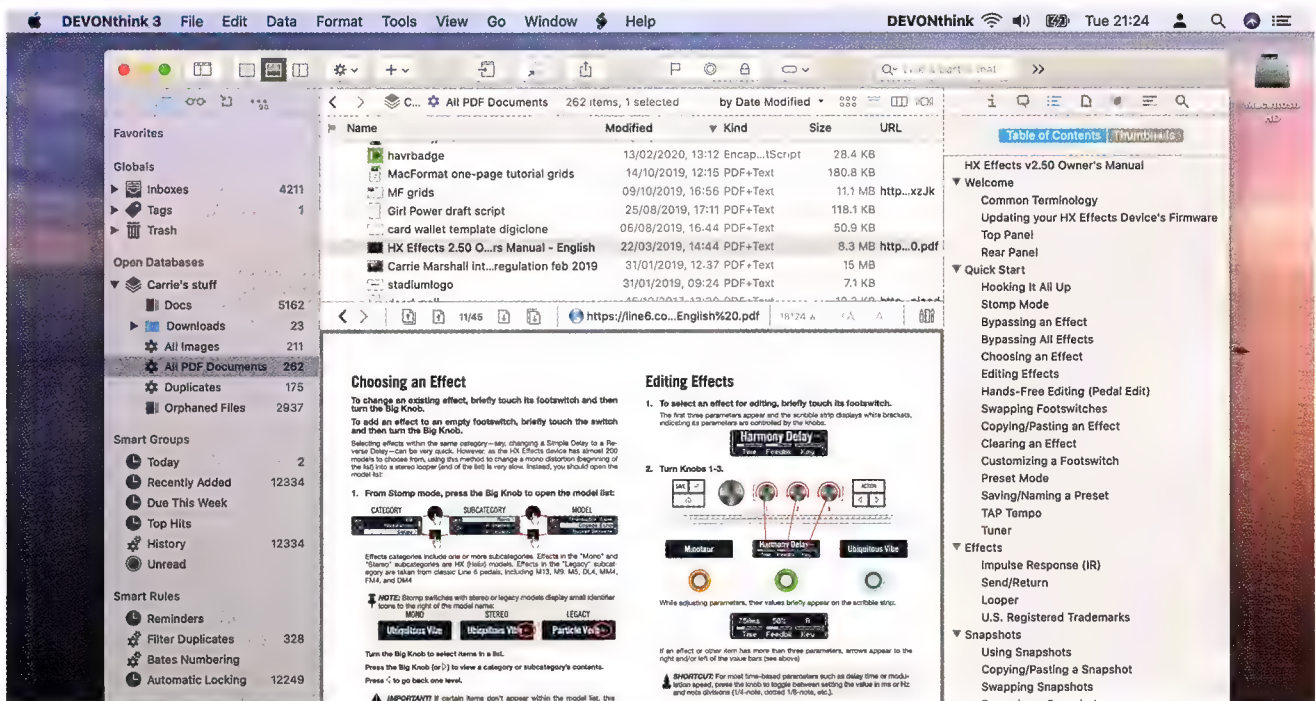
### Epic

Free games! Takes less from developers and speedy downloads, but a relatively limited range of games.

★★★★☆







Mac OS X 10.11 or later | \$140-\$700 | [devontechnologies.com](http://devontechnologies.com)

# DEVONthink 3.5

A universal inbox for every kind of data.

DEVONthink is a universal inbox for every kind of information, enabling you to store, find, and reuse any kind of content.

If you're already a DEVONthink user, you'll be pleased to discover that version 3.5 brings an updated sidebar, more options for automating repetitive tasks, syntax colouring for Markdown, better web page capture, and improved performance and stability.

DEVONthink comes in three versions: Standard (\$140), Pro (\$199), and Server (\$499). Server is for teams, and Pro takes the Standard edition's features and

adds OCR for scanning documents, the ability to automatically stamp and number documents, email archiving, custom metadata and item grouping.

There are lots of ways to get data into DEVONthink. You can import or link to external files and folders, but you can also pull data from Notes or Evernote, browser bookmarks and (in the Pro version) scanned documents, UNIX mailboxes, websites, and Bookends references.

There are web browser extensions for Chrome and Firefox, but not Safari: security



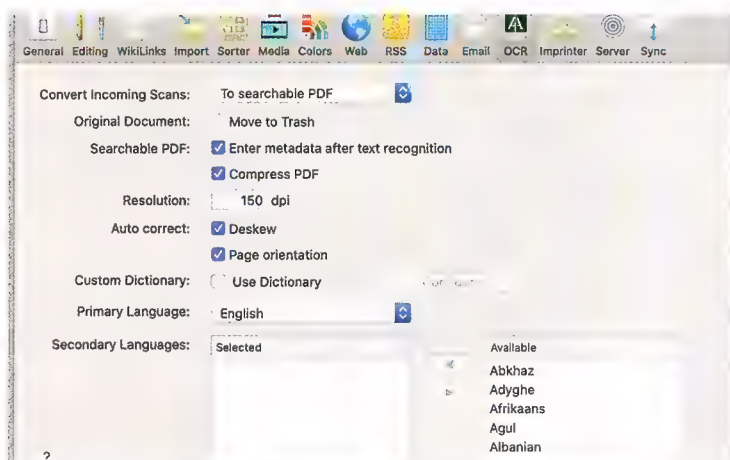
**Above:** DEVONthink enables you to store everything in one place and easily find it again.

changes in macOS Catalina mean that traditional browser extensions no longer work in Apple's browser. Instead, DEVONthink provides a range of bookmarklets you can add to your Favourites bar to save the selected page as PDF, text, HTML, an archive, or a bookmark. It also puts a collection of capture tools (text, audio, video, screenshots, and web content) and a menu of scripts onto the menu bar.

DEVONthink also adds several context-sensitive options to your Mac's Services menu. These enable you to take a selection and take or add to a plain or formatted text note, create a summary, create a Markdown document or, in Safari, capture the page as a web archive.

Once the data's in you can convert, annotate, organise and classify with folders, tags, star ratings and automatic categorisation. And you can export data in its original format or as OPML, PDF, RTF, text, Word, as a website, or as a template.

CARRIE MARSHALL



**Left:** Pro customers also get multilingual OCR for turning scanned documents into searchable PDFs.

A powerful information storage and retrieval system for power users who need to combine a lot of data.

★★★★☆



Free (IAPs) | noto.ink | NEEDS iOS 13 or later

# Noto – Elegant Note

An app that allows you to do so much more than just take notes.



While Apple's Notes app has gained functionality in iOS, it's still fairly basic, and Pages is better suited to long-form writing. Noto is a dedicated note-taking app for iOS (and also for the Mac) that lets you add rich media content, while keeping its focus on usability. It's free but some features like adding attachments and exporting require a Pro subscription (\$1.49/month, \$16.49/year, or \$38.99/lifetime).

Noto is straightforward, with a library view where you can create, open, and rearrange your notes. To the right, or fullscreen if you prefer, is the note canvas. There are two ways to enter information: creating it inside the app or dragging and dropping content from other apps. With the first method, tapping on the canvas lets you enter text, with formatting, lists, and indents available. The Add button reveals a menu where you can choose different types of data to create or import. These include a document scanner which accesses your camera, Photo library, text and other docs via the Files app, tables, manual drawing tools, math, code, and quotes. For each of these you get various options and presets to customise the content. Videos can be imported too.

Once created or imported, Noto treats content like blocks, and these can be moved around by



You can manage notes in the library and embed documents and other content in a project.

You can access your photo library to add captions, tables, and text to your canvas.

pressing and dragging. The second technique for importing is to call up an app in Split View and drag something in. This works with content from Notes, Photos, Files, web browsers and more, with Noto correctly copying formatting, hyperlinks, and more.

## Input and sync

You'll get a little more out of the iPad than the iPhone version, since iPadOS supports multiple selection and dragging of more than one item at once. Noto also supports Bluetooth mouse, trackpad and

cursor on iPad, as well as keyboard input, and these are a game-changer when it comes to productivity. This is the kind of app that benefits from expanded input options. Touch works well, but selecting and dragging content with a mouse, and using keyboard shortcuts to edit content is faster.

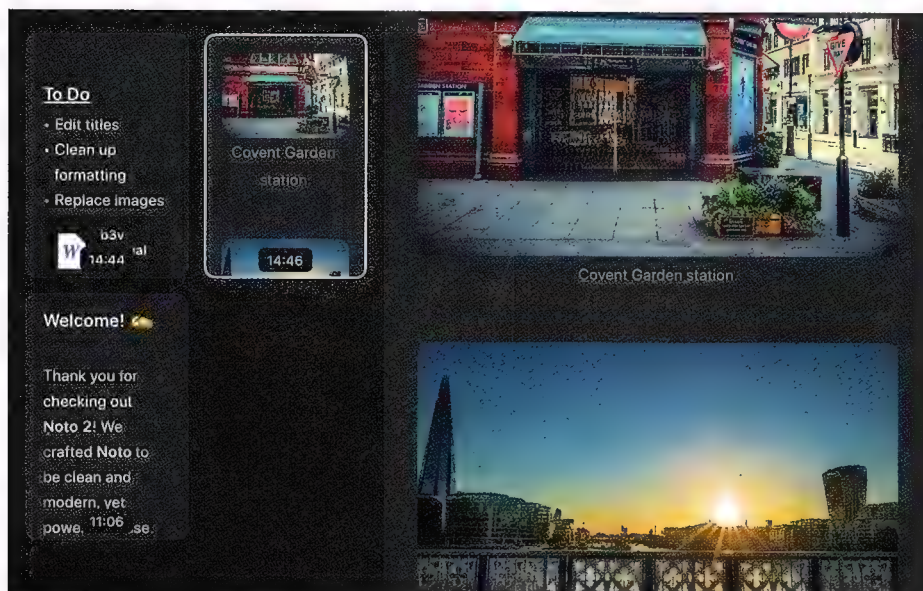
Behind the scenes, Noto syncs using CloudKit, which means your projects are quickly synced and available to your other devices, including your Mac. Exporting notes, which is one of the pro features, gives you some great options. You can export as a raw Noto project, HTML, PDF, Markdown, or a JPEG to a local or cloud-based destination.

As a tool to create reminders, lists, presentations, or just collect and organise your information in a way that's powerful but friendly, Noto is excellent. It handled pretty much everything we asked of it, got the formatting right, and provided essential tools for annotating, editing, and generally working with multiple types of media.

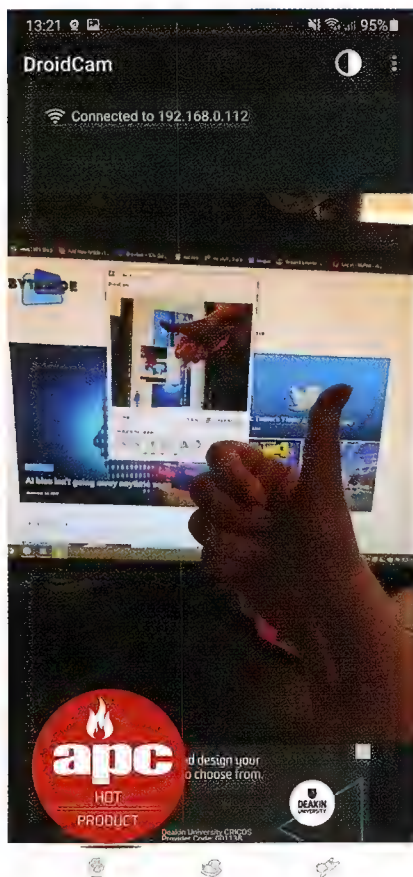
HOLLIN JONES

Noto makes it easy to create rich canvases with text, images, and more.

★★★★★







Android

## DroidCam/X

Ditch your webcam.

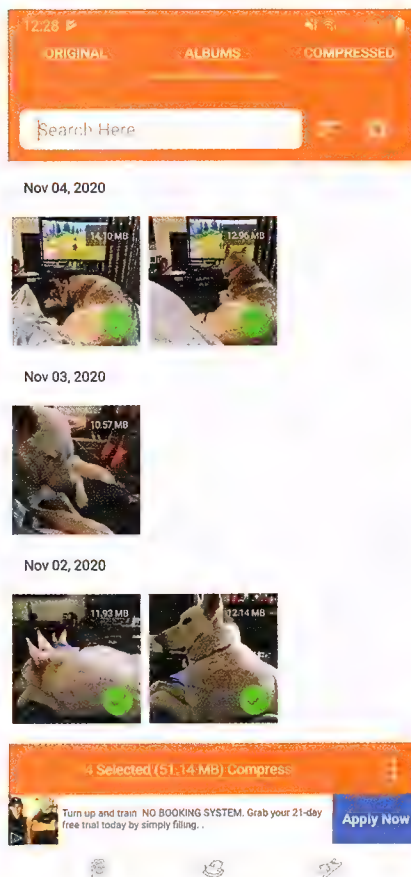
Free/\$4.99

Every video call I'm on (and there are a lot nowadays) I lament my webcam. Even though I have a fairly good one, it just seems the case that most webcams aren't really up to snuff. Mine has an especially difficult time with things like white balance and general quality. It's baffling, especially when you consider how good the cameras jammed into most phones are by comparison.

The point I'm getting to is DroidCam is a wonderful app that lets you use your phone as a webcam. It works wired, or wirelessly with its free-to-download PC app using your wifi and IP addresses and does a pretty fantastic job. There's a paid version called DroidCamX which only costs \$4.99 and gives you a bit more control, though the free app is still very good. It's also a great idea for people who don't have webcams, as you're far more likely to have a compatible phone. Using this app will save you that webcam money, and probably do a better job.

HOPE CORRIGAN

★★★★★



Android

## Auto Photo Compress

smaller.jpeg.

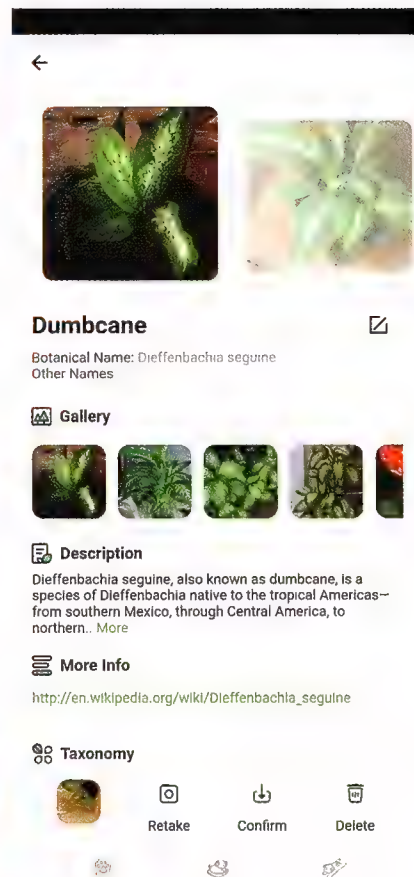
Free/subscription

The increase in phone camera quality has also led to an increase in photo file size on phones. For some uses this is great. Having the high resolution and detail in your pocket is wonderful for professional use. However, running out of storage faster than the speed of a camera flash is frustrating if this isn't a feature you use. Lots of apps will let you resize images one by one, but Auto Photo Compress lets you do a bunch at once. The pro version even lets you schedule a mass refresh, back up high quality photos, and link them to other accounts such as Google Photos or Dropbox.

It's great in that there's an automatic process where it compresses your pics the best it can, and it does a good job of keeping quality. You can't choose the end file size, and you can't compress an already compressed photo, so if you want super small files for a specific reason, this app may not help.

HOPE CORRIGAN

★★★★☆



iOS/Android

## PlantStory

Based on a true story.

Free/Subscription

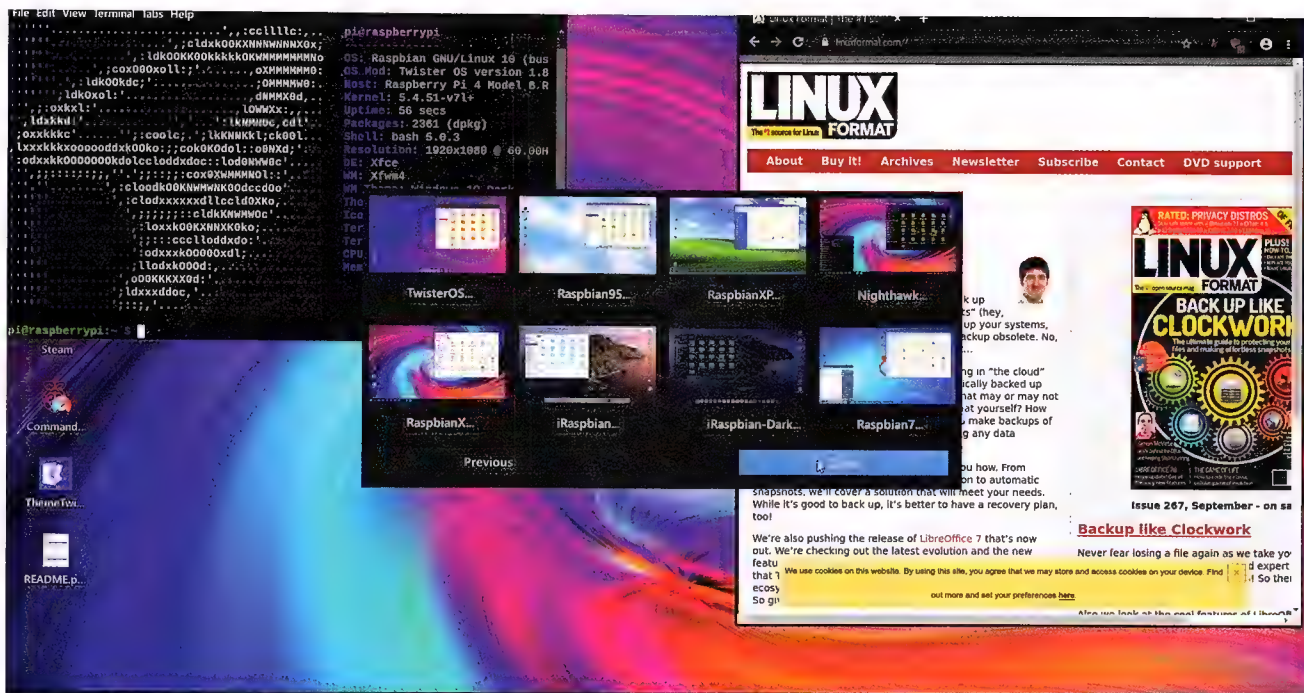
I am always on the lookout for a better plant identification app and with PlantStory getting decent reviews in the new section of app stores, I wanted to give it a shot. Like many apps in a similar vein the idea is you take a picture of a plant and it searches its database to tell you what it is, show you other pictures, and give you some extra information.

Like all apps of its ilk, this works far better on plants with distinguishing features like flowers or interesting leaves. Partly because they are easier to identify, but also because people take more pictures of them, feeding more data into the system. For the more boring plants in my house, this means it had about a 50 percent success rate. Sometimes these are way off but more often it gets pretty close. It mistook a few of my plants for a flowering version of the same genus, which is a pretty understandable mistake.

HOPE CORRIGAN

★★★★☆





Linux | www.twisteros.com

# Twister OS

Les Pounder has long used Raspberry Pi OS for his projects, but this new distro puts a new spin on the popular operating system.

Since 2012 Raspberry Pi OS (formerly known as Raspbian) has been the dominant OS on the Pi. Initially a crude yet effective OS, over time it's evolved into an exceptional platform for makers. That supremacy may soon be challenged by Twister OS, a version of Raspberry Pi OS that offers much more. Twister OS is based on the latest Raspberry Pi OS 32-bit image and has been developed for use on the Raspberry Pi 4. It can be used on the 3B+, but performance will suffer. Twister OS's origins means that projects such as the GPIO, Camera and all of the add-on boards will be fully compatible.

Everything that comes with Raspberry Pi OS is present on Twister OS, but looking through the menus it soon becomes clear that there's plenty more on offer. There are two versions of Chromium: the standard version and a version that's been tweaked to work with the Widevine DRM, which is used by streaming services. This makes it possible to watch streaming content on the Pi.

PIKISS is a utility to tweak the Pi setup and it can be used to overclock, and install software and games. It's an excellent tool that offers a simple means to administrate your system, and is constantly being updated.

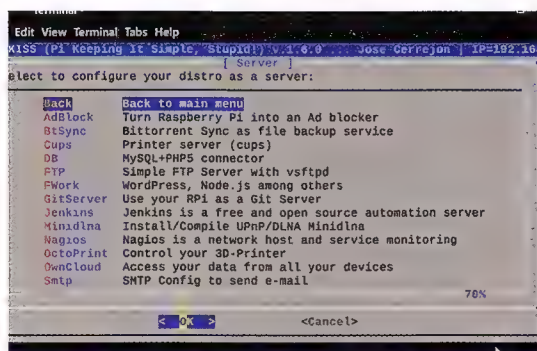
On the desktop is an icon, My Android, which is really an application called scripy. This is used to connect an Android device to a computer, such as your Pi. Using scripy is simple, but requires USB debugging to be enabled on your Android device. Your Android device will appear as a window on the desktop, and you can interact with it using the keyboard and mouse. Running scripy from the terminal unlocks extra features such as recording video that's playing on the Android device – useful for screencasts and YouTube videos.

If you're keen to overclock your Raspberry Pi 4 then Commander Pi is for you. The program provides system information (RAM, CPU usage and temperature) and information on the bootloader/

Twister OS can be themed to match Windows and macOS operating systems, and they all look fabulous.



PIKISS isn't exclusive to Twister OS, but it's still fantastic. It simplifies many complex tasks, and is constantly being updated.



firmware in use. Commander Pi utilises a GUI for overclocking your Pi, suggesting recommended settings for your Pi together with maximum settings. It's easy to use and effective – just remember to add cooling to your Raspberry Pi 4!

Gaming on a Pi typically means retro gaming and Twister OS comes with RetroPie pre-installed. Just add your ROMs, plug in your controller and you're ready to play. Twister OS also comes with box86, which makes it possible to run x86 programs on the ARM-based device.

We've saved the best till last. Twister OS looks stunning and is a breath of fresh air, but if you fancy a change then you can change the theme of Twister OS to one of eight different options, some of which look rather familiar... Twister OS can be instructed to look like Windows 95 to 10, or the theme can be changed so that it resembles macOS (OS X). We have to be honest: the themes are exceptionally close to their source material.

Twister OS is fantastic. It provides us with the compatibility that we require, along with plenty of useful applications. And who can resist that little extra eye candy, in the form of those OS themes? If you have a Raspberry Pi 4, you need to try this OS.

This is Raspberry Pi OS, but with a whole heap of extra bells and whistles! It's a great distro and is a lot of fun to use.

★★★★★



# 10

## WAYS TO CUSTOMISE YOUR ANDROID PHONE TO MAKE IT FEEL LIKE NEW

Don't settle for the same old default look, plus get to grips with what's new in Android 11.

David Nield & Tom Bedford





One of the benefits of going with an Android phone for your daily driver is that you've got an almost limitless number of ways to customise it.

While iOS remains mostly locked down in terms of how you can tweak its look and feel – even after iOS 14's changes – Android lets you plot a pixel-by-pixel remake of your device, if you want.

From simply changing the wallpaper to installing a completely different launcher, you've got plenty of options – and it can make you feel like you've gone out and bought a brand new phone, without any of the associated costs.

Whether you're an Android veteran or a complete newbie when it comes to Google's mobile operating system, we'll guide you through some of the best customisation options available. Some will take you just a few minutes, while others require a bit more of a time investment, so however you're looking to revamp your phone, you should find something of interest here.

Don't panic about messing up your phone either: all of our customisations bar one (which we'll get to later) can easily be rolled back, so if you find yourself missing the default look that your phone originally came with then it's by no means gone forever.

For the purposes of this guide we'll be outlining the steps you can take using the latest stock Android 11 software on the Google Pixel phones. If you're using an older version of Android or a different handset, the steps you need to take might vary slightly, but the same features should be available.

## 01 Change up the wallpaper

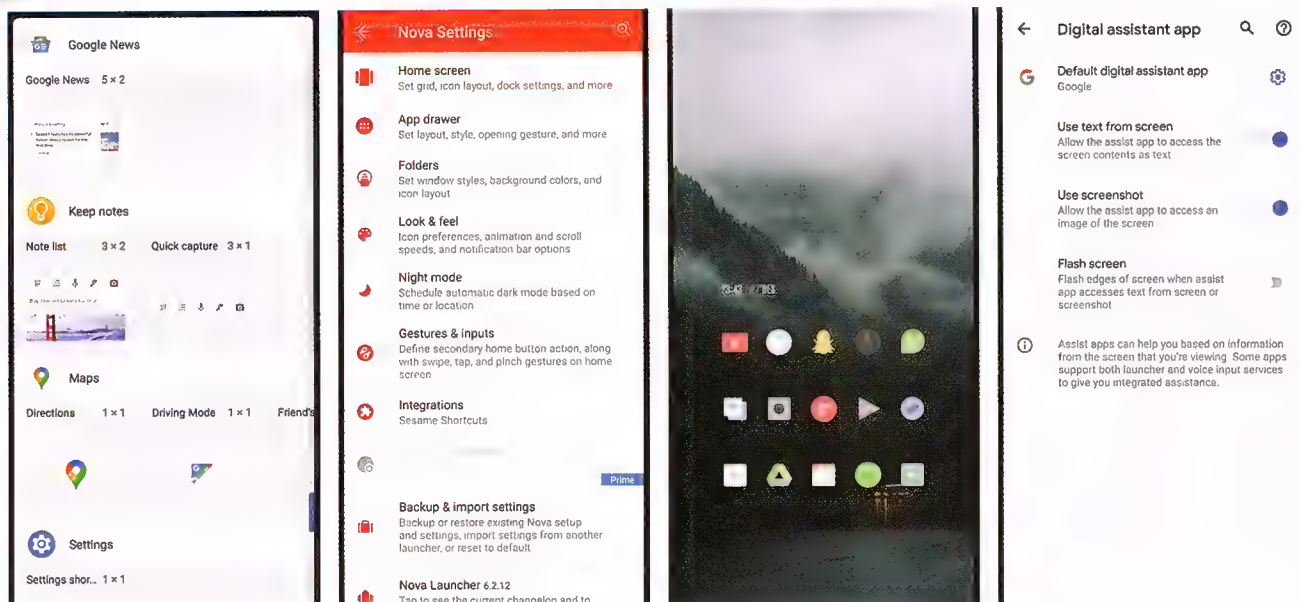
You spend a lot of each day staring at your phone's wallpaper, so make sure it's something that you like: you can change the wallpaper by long pressing on a blank area of the home screen, then choosing 'Styles & wallpapers' followed by 'Wallpaper'.

When you've chosen an image, you have the option to set it as the backdrop for your home screens, your lock screen, or both.

Plenty of phones come with an interesting selection of wallpapers already available, so make sure you've taken a good look at what there is. You can of course load in your own pictures if you prefer, or take a look at free image sites such as Unsplash (<https://unsplash.com>) and Wallhaven (<https://wallhaven.cc>) for backgrounds.







**02** Widgets can liven up your home screens.

**03** Android launchers come with a huge number of options.

**04** An alternative icon pack from Delta.

**06** Changing default apps on Android isn't difficult.

## 02 Experiment with widgets

Not only can widgets make your phone home screens look more interesting, they can be really useful as well - whether it's a calendar widget showing your upcoming schedule, or a media player widget with playback controls, they save you having to jump between quite so many open apps.

A long press on a blank area of the home screen and a tap on 'Widgets' will bring up the gallery: the widgets you see will depend which apps are installed on your phone (if there are widgets associated with your apps, they'll show up here). Of the default Google ones, Keep Notes and Google News are definitely worth a look.

## 03 Install a new launcher

Launcher apps take charge of your phone's home screen, app drawer, app icons and more - they give Android a complete visual revamp, and open up a whole host of new customisation options for you to play around with.

When you have one or more alternative launchers installed, you can switch between them via 'Apps and notifications' > 'Advanced' > 'Default apps' and then 'Home app' in Settings.

There are some excellent third-party launchers available for Android, ready to transform the look of the software - most offer a bunch of features for free, with more options available via in-app purchases.

Some of the best we've come across are Nova Launcher ([tinyurl.com/APC489NovaLauncher](http://tinyurl.com/APC489NovaLauncher)), Evie Launcher ([tinyurl.com/APC489EvieLauncher](http://tinyurl.com/APC489EvieLauncher)), Lawnchair ([tinyurl.com/APC489Lawnchair](http://tinyurl.com/APC489Lawnchair)), and Action Launcher ([tinyurl.com/APC489ActionLauncher](http://tinyurl.com/APC489ActionLauncher)).

## 04 Apply a different icon pack

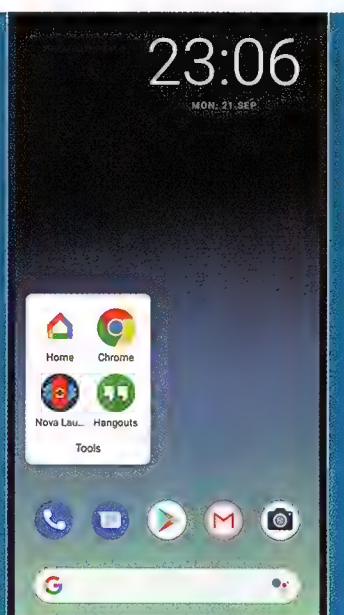
Another customisation enabled by launchers is the use of icon packs: if you check out packs like Viral ([tinyurl.com/APC489Viral](http://tinyurl.com/APC489Viral)) and Delta ([tinyurl.com/APC489Delta](http://tinyurl.com/APC489Delta)) on the Google Play Store, they'll list the launchers that they're compatible with, so you should be able to find several that match up with whatever launcher you prefer.

Icon packs change all the icons on your home screen - for Gmail, Twitter, Netflix and so on - to match one particular style or theme, and they often come with

## 05 Rearrange your home screens

Whether or not you have a launcher installed, Android gives you plenty of flexibility when it comes to getting app icons, web shortcuts, and widgets arranged on your home screens - just tap, hold and drag on any icon to move it around (remember you can have multiple home screens stretching off to the right).

You can keep shortcuts on the left of the screen, for example, or near the bottom (where they're much easier to access if you're using a phone with a large display). To create a folder of app icons, just drag one on top of another, and then tap on the folder itself and then its name to rename it to something else.





accompanying wallpaper. If you have a look around the various options, you'll see they can change the appearance of Android quite dramatically.

## 06 Swap out the default apps

Android lets you choose default apps for tasks like opening email links, web pages and media files – so if you prefer an email app, web browser, or media player that isn't the one that Android has picked for you, you can switch pretty easily.

To check and change the defaults that are currently set up inside Android, open Settings and then choose 'Apps and notifications' > 'Advanced', and then 'Default apps'. You can even change the digital assistant Android uses, but you'll need to install some alternatives (like Amazon Alexa for digital assistants) before they'll show up in these menus.

## 07 Take control of sounds

You might not give much thought to the bleeps and whistles that your phone makes, but customising the sounds emanating from your handset is a great way of personalising it – and you've got lots of options here, from famous guitar riffs to movie theme tunes. You can even add your own if you don't like the bundled selection.

Head to the 'Sound' menu in

Settings to assign different melodies and jingles to your incoming calls, messages, and other notifications. You can even create different ringtones for different contacts: open up an entry in the Contacts app, then tap the three dots to the top right, and choose 'Set ringtone'.

## 08 Check the theme settings

Android has started to introduce some native theming tools of its own, following the lead of the launcher apps that we mentioned earlier. The exact tools you'll see will depend on the make and model of Android phone you're using, and how many customisations the manufacturer has added to Google's mobile operating system.

In the case of Pixel phones, if you go from Settings to 'Display' > 'Advanced' and then 'Styles and wallpapers', you'll find a choice of icon shapes, colours, fonts and wallpapers to pick from. You can choose from the themes (or styles) that Google has provided, or build your own custom one.

## 09 Switch to the dark side

Speaking of themes, Android now includes a dark theme, which will definitely change the look and feel of the interface (many apps should follow the

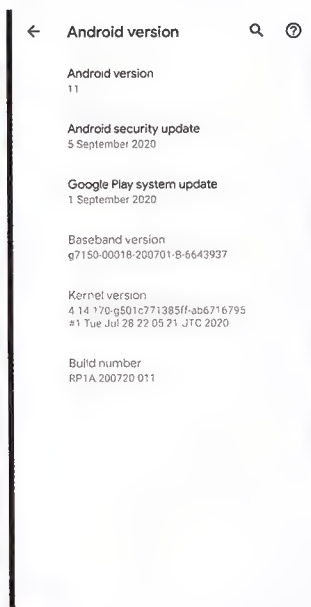
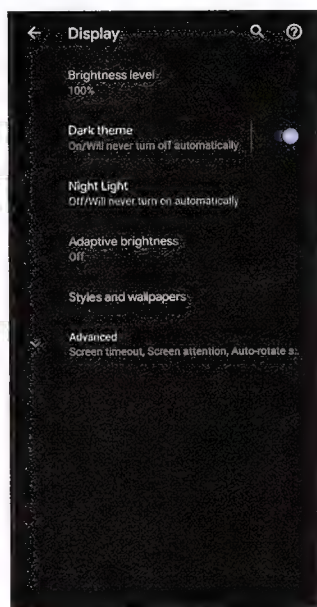
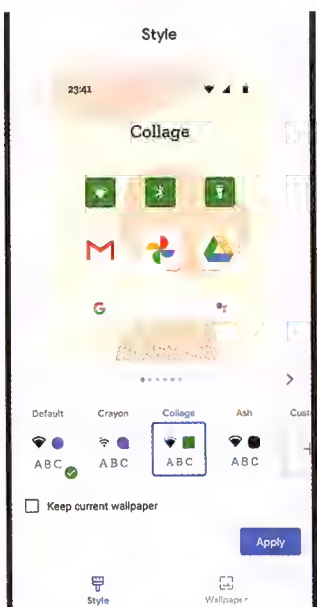
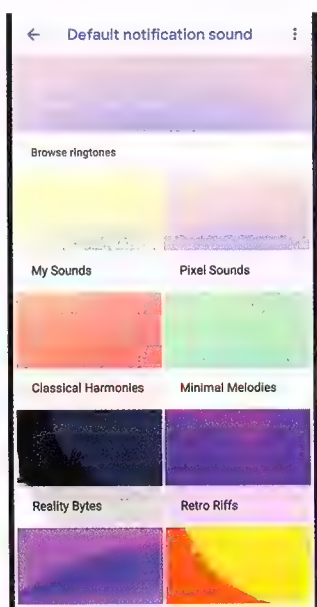
lead of the operating system and change their hues too). You can find the 'Dark theme' option under 'Display' in Settings.

You can turn the dark theme on and off manually if you prefer, or schedule it to be enabled and disabled at certain times of the day (or night). Tap 'Schedule' to set up timings, or to have dark mode automatically kick in between sunset and sunrise in your location.

## 10 Root your Android phone

For the ultimate in customisations, rooting your Android phone remains an option – it's a technical, involved process, and it will void your warranty, but it does give you the freedom to do whatever you like with your phone (even install a different OS, like the one at [lineageos.org](http://lineageos.org)).

We don't have the room here to take you all the way through a guide to rooting your Android phone, but there's an excellent introduction at XDA Developers ([www.xda-developers.com/root](http://www.xda-developers.com/root)). Remember that you do this at your own risk, so weigh up the pros and cons of rooting your phone before deciding to get started.



07 You've got a huge number of sounds to pick from on Android.

08 Some theming options are now built into Android.

09 Make sure dark mode comes on when you want it to.

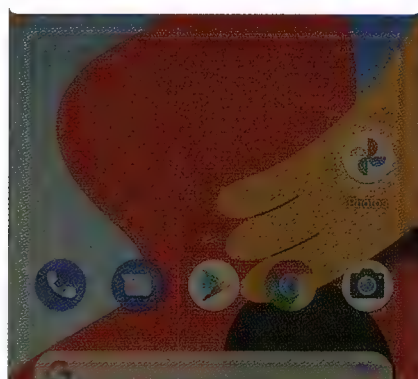
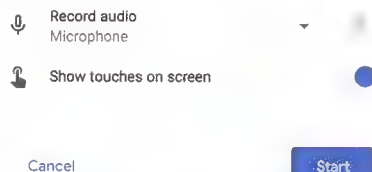
10 Get rid of Android entirely by rooting.





### Start recording?

While recording, Android System can capture any sensitive information that's visible on your screen or played on your device. This includes passwords, payment info, photos, messages and audio

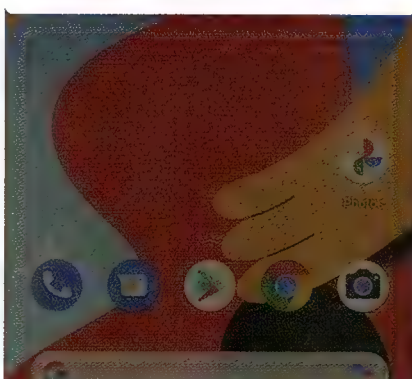
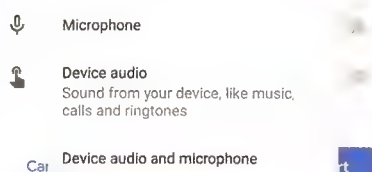


Android 11  
screen recorder.

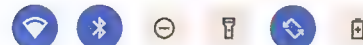


### Start recording?

While recording, Android System can capture any sensitive information that's visible on your screen or played on your device. This includes passwords, payment info, photos, messages and audio



Wed, 9 Sep



Screen Recorder • 00:05

Recording screen  
Tap to stop

Notifications

Slack • Future • 3m

(2) James Peckham  
Will reply in a bit

WhatsApp • now

WhatsApp Web  
WhatsApp Web is currently active

Silent

Twitter • 8m

GadgetsBoy  
@GadgetsBoy liked: Winter is coming https://t...

Google • 22" in Chelmsford • 28m

Manage

Clear all

# The best new features in Android 11

Android 11 is out for all.

Google released Android 11 on September 8, 2020 – we were expecting this date thanks to leaks from the company, but Google itself didn't build up much fanfare for the new operating system.

Well, September 8 marked the release of Android 11 on Pixel phones, but if you own a handset from a company other than Google, you'll have to wait.

Manufacturers with custom forks of Android will now need to build their own versions of Android 11, then roll them out to their smartphones – that could be quick, for newer flagships, but if you've got an older or mid-range handset you might be waiting a while.

We do know Nokia's Android 11 rollout schedule, as the company announced as much in a Tweet. It seems the first phones will get Android 11 towards the end of 2020 or beginning of 2021, but some handsets, like 2019's flagship the Nokia 9 PureView, will be waiting quite a bit longer.

## Built-in screen recording

Android 11 brings a feature some custom Android forks already have – built-in screen recording. This lets you use easily-accessible controls within the phone to create a video of what's on your screen, similar to screenshots.

You can even record the sound of your phone, or use the mic to narrate what you're doing, so this should be a great feature for creating short-form video like TikToks, or for making tutorial videos to help less tech-savvy relatives make the most of their smartphone.

Related to this, the Android 11 sharing functions have seen wider rollout to apps, so you can easily copy and paste images, text and videos from one app and send them straight to another.

## New conversations tab

When you swipe down from the top in Android 10, you bring down your notification bar – well, in Android 11, that's split into two sections, consisting of your notifications, and your 'conversations'.

These conversations are basically

just chat notifications from chat apps like WhatsApp, Facebook Messenger and Twitter, so you know they're probably more worth paying attention to than the other notifications.

This way you can easily see if people need you, and reply straight away too. You can also now pin conversations to 'Bubbles' – you might have seen these for Facebook Messenger, where a floating icon appears above other apps to show you that you have a message.

Now you can get messages from more apps to appear as bubbles, and you can pin them there too so the chat is always easily-accessible.

## Smart home and media controls

The new Android 11 update brings loads of changes for people who use loads of smart home devices.

From one easily-accessible menu (accessed by long-pressing the power button) you can control all the IoT (Internet of Things) devices you have connected to your phone, as well as NFC bank cards.

Talking of home, there's a new



Bedtime Mode in the phone which you can set to run during the night, which turns on Do Not Disturb and makes the phone screen black-and-white to protect your vision.

There are new media controls too. It's now easier to make music play from other devices connected to your phone, like Bluetooth speakers or other gadgets.

### Improved accessibility

Google has improved its Voice Access mode in Android 11, although there isn't too much information on what's changed.

Apparently, the hands-free mode is now 'faster and easier to use' – a bigger change is that the mode now works offline, so you don't need to always be connected to use it. These changes should hopefully make Android 11 a lot more accessible, letting people stay connected regardless of disability.

A cool new mode is the braille keyboard, so you can write braille messages without needing to buy separate software.

Finally, the Lookout app now lets you scan documents and food labels, so people with limited vision can still 'read' documents and see what's in their food.

### Improved prediction tools

Android 11 will seemingly reduce the work you need to do on your phone, by predicting your habits and patterns. One such example of this is smart folders, so you can let Android 11 automatically sort your apps into folders of similar apps, like games or productivity tools.

App suggestions is also tweaked to suggest apps based on your routine – for example, if you always log onto your Fitbit app first thing in the morning to examine your sleep habits, the phone will now automatically pop that app into the Home screen in the morning so it's easily accessible.

### Security and privacy

The Android 11 update brings some changes to app permissions. Now, you can grant an app permission to, say, your camera or location, on a one-off basis, instead of the existing options of 'all the time' and 'only while using the app'.

In addition, your phone will automatically revoke permissions for apps if you haven't used them in a while, so an app won't track your location if you forget you have it downloaded, for example.

### Other useful features

There are a few new Android 11 features which don't fit into the above categories.

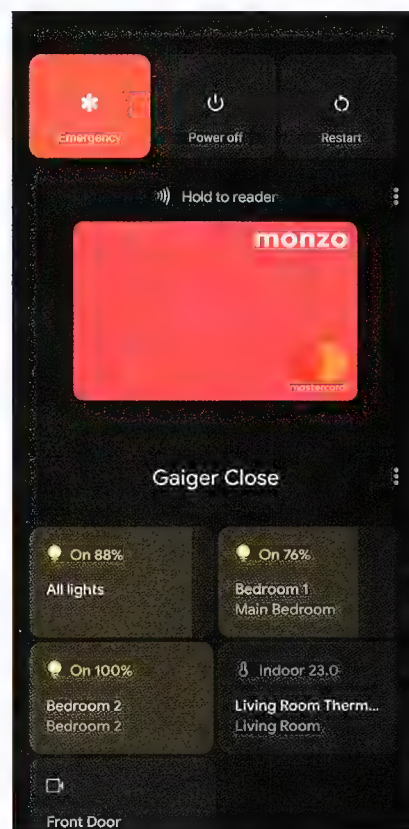
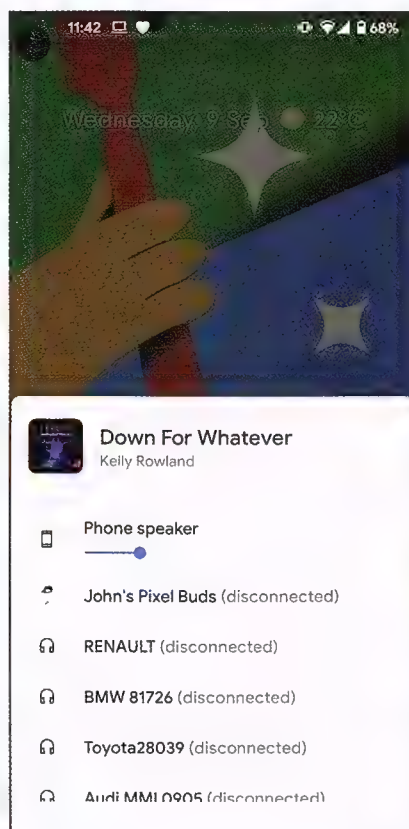
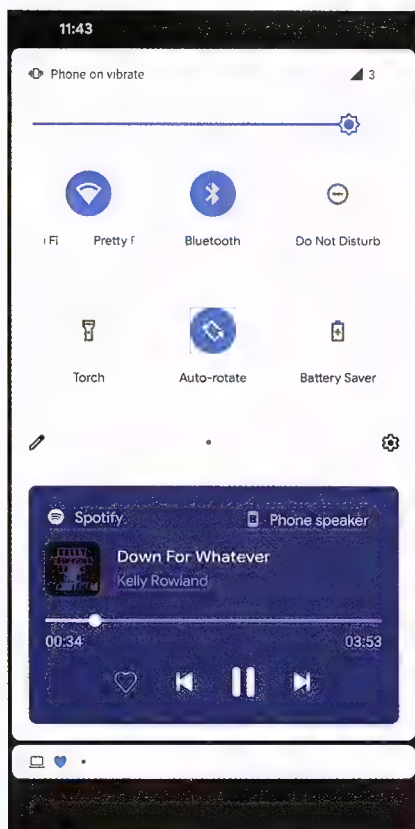
One of these is better 5G detection, so if you're using a 5G phone Android 11 apps will recognise this more easily, and run faster as a result.

On the topic of improved innovative software, Android 11 will now detect hinge angles on foldable phones, so apps can better run when your foldable phone isn't flat.

Picture-in-picture mode is a useful way of watching videos while you do other things, and now it's easier to change the size of the window so you can better fit whatever else you're doing.

There's a new 'Nearby Share' mode which lets you easily send information and data to nearby devices like your tablet, Chromebook or computer using Chrome, so you can easily send a document from your phone to your PC, for example.

Finally, you can now see older notifications in settings, in case you accidentally swiped one away or ignored it for too long. **TL**



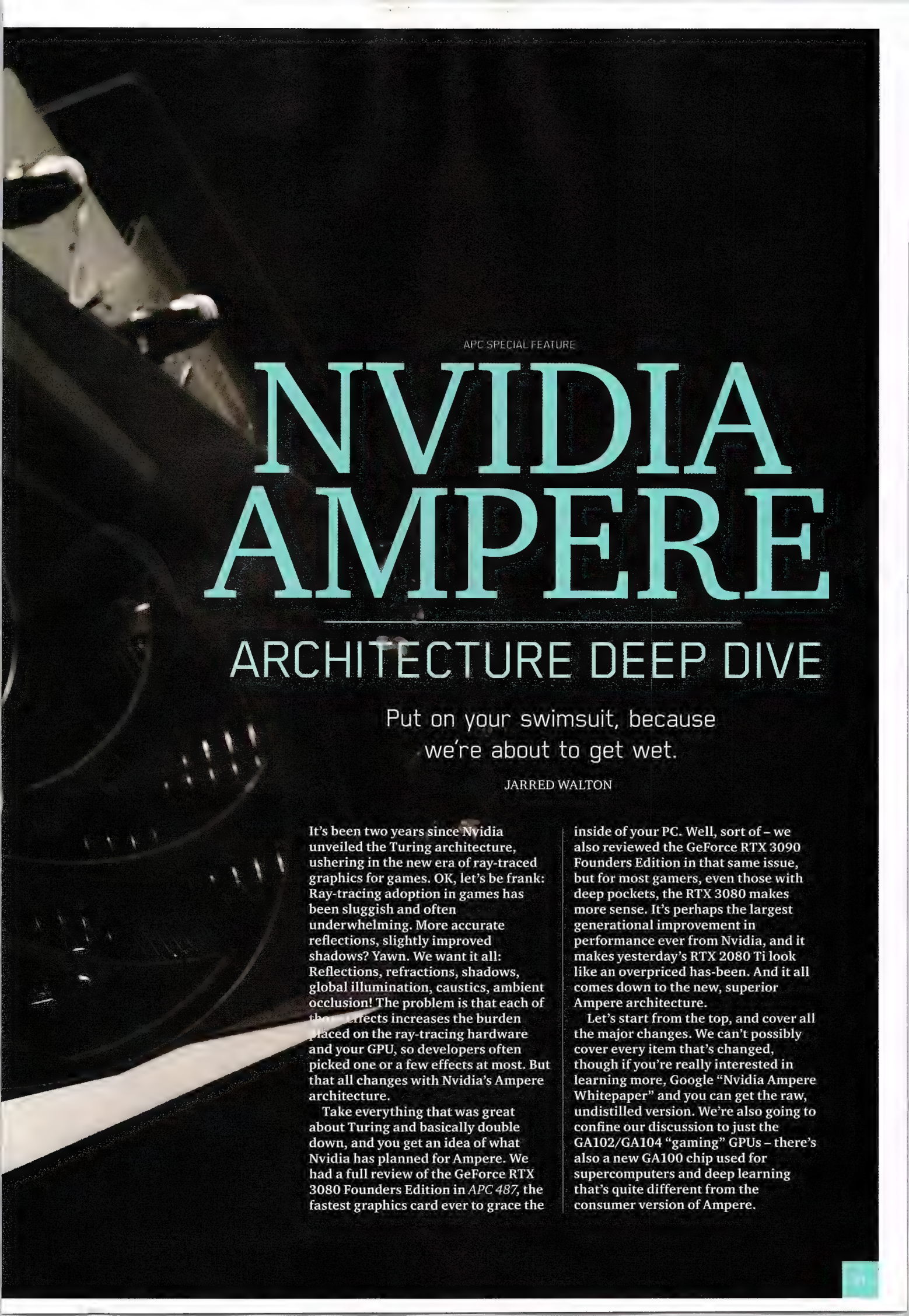
Android 11 media and smart home controls.



ORCE RTX







APC SPECIAL FEATURE

# NVIDIA AMPERE

## ARCHITECTURE DEEP DIVE

Put on your swimsuit, because  
we're about to get wet.

JARRED WALTON

It's been two years since Nvidia unveiled the Turing architecture, ushering in the new era of ray-traced graphics for games. OK, let's be frank: Ray-tracing adoption in games has been sluggish and often underwhelming. More accurate reflections, slightly improved shadows? Yawn. We want it all: Reflections, refractions, shadows, global illumination, caustics, ambient occlusion! The problem is that each of those effects increases the burden placed on the ray-tracing hardware and your GPU, so developers often picked one or a few effects at most. But that all changes with Nvidia's Ampere architecture.

Take everything that was great about Turing and basically double down, and you get an idea of what Nvidia has planned for Ampere. We had a full review of the GeForce RTX 3080 Founders Edition in *APC 487*, the fastest graphics card ever to grace the

inside of your PC. Well, sort of – we also reviewed the GeForce RTX 3090 Founders Edition in that same issue, but for most gamers, even those with deep pockets, the RTX 3080 makes more sense. It's perhaps the largest generational improvement in performance ever from Nvidia, and it makes yesterday's RTX 2080 Ti look like an overpriced has-been. And it all comes down to the new, superior Ampere architecture.

Let's start from the top, and cover all the major changes. We can't possibly cover every item that's changed, though if you're really interested in learning more, Google "Nvidia Ampere Whitepaper" and you can get the raw, undistilled version. We're also going to confine our discussion to just the GA102/GA104 "gaming" GPUs – there's also a new GA100 chip used for supercomputers and deep learning that's quite different from the consumer version of Ampere.





## Lithography: The foundation of every chip

Every chip design starts by choosing how the part will eventually be made. Most of Nvidia's GPUs of the past two decades have come from TSMC (Taiwanese Semiconductor Manufacturing Company), but Nvidia has also used Samsung for some parts. The GA102 and GA104 chips destined for the RTX 30-series cards will use Samsung 8N, an "Nvidia-optimised" 8nm process technology that's basically Samsung's 10LP+ +++. That's almost as many "+" revisions as intel's 14nm node! This brings along some good improvements compared to Turing (TSMC 12FFN), allowing for more transistors in a smaller space.

However, let's be clear: TSMC's N7 lithography is undoubtedly better overall, if you're just looking at performance. It's also in much higher demand, which is almost certainly why Nvidia opted for Samsung. TSMC is currently busy taking orders from AMD for Zen 2 and Zen 3, RDNA 1 and RDNA 2, and Nvidia's own GA100 chips – plus Apple and various other customers. Word is that TSMC is basically in such high demand that it can charge a premium, and it does.

Just from a high level, however,

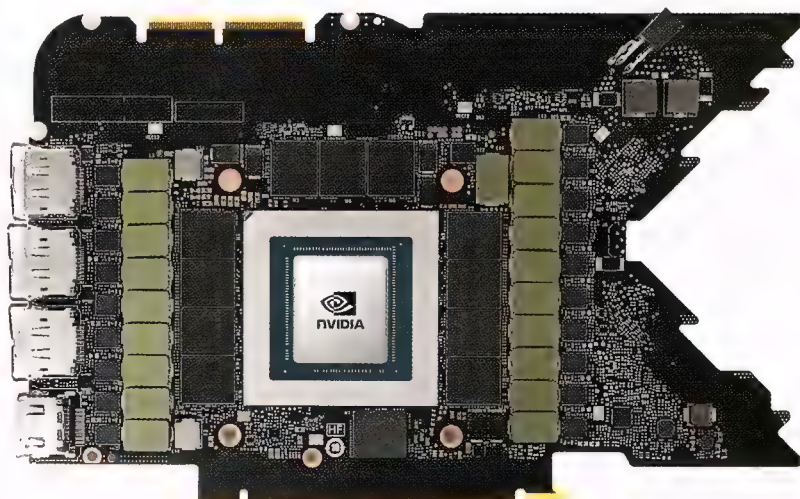
This "simplified" block diagram illustrates just how complex modern GPUs have become.

Samsung 8N is still a healthy jump for Nvidia. Consider the previous-generation TU102 GPU used in the RTX 2080 Ti. It has 18.6 billion transistors crammed into a massive 754mm square chip. The Ampere GA102 by comparison has 28.3 billion transistors in a 628mm square chip. It's not entirely apples to apples, since the various types of logic used on a chip – GPU cores, cache, memory controllers, video decoders, etc. – have different densities, but at a high level Nvidia is putting 52 percent more transistors into 17 percent less space. That's a relative density

improvement of over 1.8x.

As another example, the GA104 chip (which will be used in the RTX 3070) packs 17.4 billion transistors into 392.5mm square. Again, that's about 1.8x the transistor density of last gen. Alternatively, Nvidia's GA100 packs 54 billion transistors into an 826mm square using TSMC N7, which is nearly 50 percent more transistors per square mm. GA100 has plenty of other differences, but it's clear Nvidia used TSMC N7 for GA100 because it was the best "money is no object" choice for a data center class GPU.

There are some downsides to



The GeForce RTX 3090 packs in 24GB of GDDR6X memory into its tiny PCB.



## Nvidia Ampere GPU specifications

|                                      | RTX 3090     | GEFORCE RTX 3080 | RTX 3070      |
|--------------------------------------|--------------|------------------|---------------|
| GPU CODENAME                         | GA102        | GA102            | GA104         |
| GPCS                                 | 7            | 6                | 6             |
| TPCS                                 | 41           | 34               | 23            |
| SMS                                  | 82           | 68               | 46            |
| CUDA CORES / GPU (FP32)              | 10,496       | 8,704            | 5,888         |
| TENSOR CORES / GPU (3RD GEN)         | 328          | 272              | 184           |
| RT CORES (2ND GEN)                   | 82           | 68               | 46            |
| GPU BOOST CLOCK (MHZ)                | 1,695        | 1,710            | 1,725         |
| FP32 TFLOPS                          | 35.6         | 29.8             | 20.3          |
| FP16 TFLOPS                          | 35.6         | 29.8             | 20.3          |
| INT32 TOPS                           | 17.8         | 14.9             | 10.2          |
| FP16 TENSOR TFLOPS (FP16 ACCUMULATE) | 142 / 284    | 119 / 238        | 81.3 / 162.6  |
| FP16 TENSOR TFLOPS (FP32 ACCUMULATE) | 71 / 142     | 59.5 / 119       | 40.6 / 81.3   |
| BF16 TENSOR TFLOPS (FP32 ACCUMULATE) | 71 / 142     | 59.5 / 119       | 40.6 / 81.3   |
| TF32 TENSOR TFLOPS                   | 35.6 / 71    | 29.8 / 59.52     | 20.3 / 40.6   |
| INT8 TENSOR TOPS                     | 284 / 568    | 238 / 476        | 162.6 / 325.2 |
| INT4 TENSOR TOPS                     | 568 / 1136   | 476 / 952        | 325.2 / 650.4 |
| MEMORY SIZE AND TYPE                 | 24GB GDDR6X  | 10GB GDDR6X      | 8GB GDDR6     |
| MEMORY INTERFACE                     | 384-BIT      | 320-BIT          | 256-BIT       |
| MEMORY CLOCK (DATA RATE)             | 19.5GBPS     | 19GBPS           | 14GBPS        |
| MEMORY BANDWIDTH (GB/SEC)            | 936GB/S      | 760GB/SEC        | 448GB/S       |
| ROPS                                 | 112          | 96               | 96            |
| PIXEL FILL-RATE (GIGAPIXELS/SEC)     | 193          | 164.2            | 165.6         |
| TEXTURE UNITS                        | 328          | 272              | 184           |
| TEXEL FILL-RATE (GIGATEXELS/SEC)     | 566          | 465              | 317.4         |
| L1 DATA CACHE/SHARED MEMORY          | 10,496KB     | 8,704 KB         | 5,888 KB      |
| L2 CACHE SIZE                        | 6,144KB      | 5,120 KB         | 4,096 KB      |
| REGISTER FILE SIZE                   | 20,992KB     | 17,408 KB        | 11,776 KB     |
| TOTAL GRAPHICS POWER (TGP)           | 350 WATTS    | 320 WATTS        | 220 WATTS     |
| TRANSISTOR COUNT                     | 28.3 BILLION | 28.3 BILLION     | 17.4 BILLION  |
| DIE SIZE                             | 628.4MM2     | 628.4MM2         | 392.5MM2      |
| MANUFACTURING PROCESS                | SAMSUNG 8N   | SAMSUNG 8N       | SAMSUNG 8N    |

using Samsung 8N, however. The most obvious is power requirements. The GeForce RTX 3080 has a TGP (Total Graphics Power) rating of 320W, which is the highest single-GPU graphics card power level we've seen. The RTX 3090, meanwhile, bumps the TGP to 350W. Nvidia claims that the Ampere architecture is up to 1.9x the performance per watt of Turing, but how it derives that number is a bit tricky.

If you take an unspecified Turing GPU and an unspecified Ampere GPU and run both at the same performance level, Turing would require 1.9x more power. However,

the retail Ampere GPUs are pushing the design to its limits, and as you move to the right on the voltage/frequency curve, efficiency is greatly reduced. In our testing, looking at real-world fps/watt, the RTX 3080 FE is about 33 percent faster than the RTX 2080 Ti and uses about 24 percent more power. That's a net improvement, but nowhere near 90-percent higher efficiency. The high TGP also means that Nvidia and its partners will have to put more effort into designing high-performance cooling solutions, which explains the far larger cooler designs in general.

### Core benefits: FP32 times two

With the lithography appetiser out of the way, let's dig into the real meat of Ampere. Nvidia's basic design structure remains similar to Turing, in that each GPU has clusters of GPU cores called SMs, which are then grouped into GPCs. Each GPC also has one TPC (Texture Processing Cluster), and then there are memory controllers, a video decoding block, caches, and other miscellaneous parts. Let's run through each of those.

The SM (Streaming Multiprocessor) is the main workhorse, and it's gone through



## What are TFLOPS?

One of the base measurements of GPU performance is TFLOPS, or teraflops. What is a teraflop? It's 1 trillion "Floating-point Operations Per Second." Think about that for a moment. How long would it take you to add or multiply two numbers, like  $\pi$  (pi) and  $e$  (Euler's number)? We'll be nice and let you round off to just 3.14159 and 2.71828. Let us know when you're finished – you can even use a calculator if you want. If you have a modern graphics card, it could do that same sort of calculation anywhere from 10 trillion to 30 trillion times per second.

At its basic level, computer graphics involves math – lots and lots of math. So much math that those trillions of multiplications and additions can actually be put to good use. A lot of the calculations are matrix operations, used to manipulate and project a 3D object onto a 2D plane like your PC's display. That specific type of workload often involves multiplying two matrices and then adding a third matrix to the result, so GPUs have a special operation called FMA: Fused multiply-add.

Each FP32 graphics core can execute one such FMA each clock cycle, so to get TFLOPS you take the number of "cores" times the clock speed, times two. And that's where you get TFLOPS. Related to this is a secondary metric, TOPS – teraops. This is used when the workload isn't floating-point, so INT32, or even INT8 or INT4.

Nvidia's Turing and Ampere architectures don't just have CUDA cores, however. There are also Tensor cores, which are even more optimized to do massive amounts of math. On Turing, each Tensor core could do a 4x4x4 matrix FMA each cycle. That's 128 FLOPS per Tensor core. The catch is that the Tensor cores use a lower-precision FP16 (16-bit floating-point) format, and they're not tuned to do all the graphics calculations that the regular cores can handle. Ampere ups the ante with 8x4x4 Tensor core calculations, so twice the FP16 throughput for Tensor operations. Ampere also uses the Tensor cores for fast math (FP16) GPU calculations, but only at the same rate as the GPU FP32 cores.

various configurations over the years. Each SM has four processing blocks, which can dispatch up to 32 threads per clock (two 16-thread wavefronts). Turing had 64 FP32 (32-bit floating-point) CUDA cores per SM, plus 64 more cores for INT32 (32-bit integer) calculations, and both could be utilised concurrently. Pascal had 128 FP32/INT32 cores only – the cores could only do one or the other data type at a time. With Ampere, Nvidia builds off the Turing design while at the same time shifting a bunch of things around.

First, Nvidia sort of doubled the number of FP32 CUDA cores per SM, but it did this by adding FP32 functionality to the previous INT32 datapath. So now, Ampere has 64 dedicated FP32 cores in an SM, and then 64 FP32/INT32 cores. It can still do concurrent FP32 + INT32, just like Turing, but alternatively it can do FP32 + FP32. That means for the right workloads, Ampere has more than double the theoretical performance of Turing. (See boxout on TFLOPS.)

This has interesting ramifications for different workloads. Take a game where the instruction mix is roughly 65 percent FP32 and 35 percent INT32 – according to Nvidia, this is roughly how the average game behaves, with INT32 used for memory address calculations, texture lookups, and other less complex math. On Turing, the FP32

datapath would have ended up fully utilised, while the INT32 datapath would have only been about 50 percent utilised. With Ampere, the dedicated FP32 cores are fully utilised, but now the FP32/INT32 cores are split roughly 30/70 on FP32 vs. INT32 work.

Best-case, the RTX 3080 is theoretically 2.95x faster than the RTX 2080 at FP32 workloads. In practice, however, it is more like up to twice as fast in actual gaming performance.

### Are you feeling a little... Tensor?

Ampere packs in four 3rd-generation Tensor cores per SM while Turing included eight 2nd-generation Tensor cores per

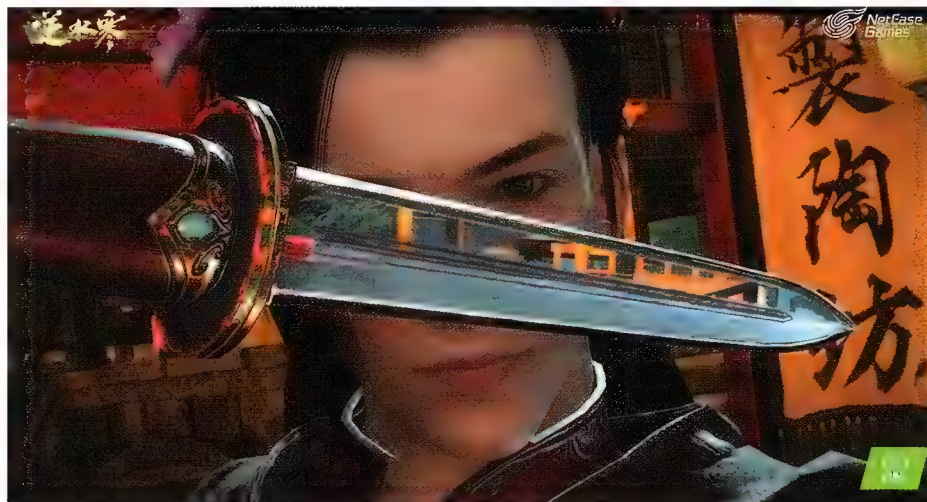
SM (incidentally, 1st-gen Tensor cores were only present in the Volta architecture, which showed up in the Titan V as well as supercomputer V100 GPUs). That means the RTX 3080 has 272 Tensor cores, compared to 368 Tensor cores in the RTX 2080. As noted in the TFLOPS discussion, however, the Tensor operations are now done on 8x4x4 matrices instead of 4x4x4 matrices, which means that each Ampere Tensor core is twice as fast as a Turing Tensor core. But that's not all.

Tensor cores are useful for deep-learning applications, where various matrices are frequently multiplied to determine new weights over time. The most important elements end up with higher weights, while elements that are deemed unimportant often end up with a weight of zero. What's zero times, well, anything? Zero! We like easy math. But if a Tensor core is doing lots of zero multiplications, that's pretty much wasted effort.

Ampere introduces fine-grained sparsity support, which allows tensor operations to basically skip all those zeroes and get to the important stuff. Nvidia claims that with sparsity enabled, on algorithms that benefit from the feature (which isn't everything), the performance is twice as fast. So, with sparsity enabled, each Tensor core in Ampere is potentially four times as powerful as in Turing.

Beyond just boosting FP16 performance, the 3rd-gen Tensor cores also gain support for new data types: BF16, TF32, INT8, and INT4. These can be useful in certain deep-learning workloads, for different purposes. BF16 is an alternative floating-point format with a 7-bit mantissa and 8-bit exponent (compared to FP16's 5-bit exponent and 10-bit mantissa).

Ray-tracing performance should improve significantly.





TF32, meanwhile, is an FP32 alternative that has the same 8-bit exponent but only a 10-bit mantissa (compared to a 23-bit mantissa for FP32). BF16 performance is equal to FP16 performance, while TF32 performance is half the FP16 rate.

The INT8 and INT4 data types (8-bit and 4-bit integers) are more for inference. INT8 are half the size of FP16, so they're twice the throughput – up to 238 TOPS with the RTX 3080, and 476 TOPS with sparsity. INT4 doubles those values yet again. These may not end up mattering much for gaming workloads, but deep learning is one of the fastest growing areas of research right now, so there's a lot of potentially groundbreaking ideas that could benefit in the future.

## Even faster ray tracing

Last but not least, Nvidia also boosted the ray-tracing performance of Ampere. It wasn't willing to go into a lot of details – AMD and Intel are still trying to figure out the optimal way to do ray tracing in GPUs, and Nvidia doesn't want to provide any hints – but Ampere's RT cores are up to twice as fast on ray-triangle intersection calculations, and overall Nvidia claims that the 2nd-gen RT cores are 1.7x faster than Turing's 1st-gen RT implementation. As before, there's one RT core per SM.

The new RT cores have also learned a few tricks. The biggest involves adding a “time” element to ray-tracing calculations, which can dramatically improve performance in motion-blur effects. Not everyone likes motion blur in games, but it's quite important in films where the on-screen results can look choppy compared to traditional film techniques that inherently capture motion blur. With the new “time stamp” addition, Ampere can be even more of an improvement over Turing in rendering accurate motion blur.

The RT cores can also run concurrently with the shader cores on Ampere, which means running a ray-tracing workload doesn't inherently cause other work to stall out for a few cycles.

## GDDR6X:

*Thanks for the memories*

All of the Turing GPUs used GDDR6 memory, mostly clocked at 14Gbps (with a few budget and mainstream GPUs clocked at 12Gbps, and the RTX 2080 Super clocked at 15.5Gbps). For Ampere, Nvidia has



partnered with Micron to create a new GDDR6X memory standard. This is very similar to what we saw with GDDR5X on the previous Pascal-generation GPUs.

Micron has GDDR6X memory rated at 19-21Gbps, with the 3080 using 19Gbps memory and the 3090 using 19.5Gbps memory. The RTX 3070, meanwhile, sticks with 14Gbps GDDR6 memory, though GA104 can support GDDR6X as well (i.e., for a future RTX 3070 Ti, maybe). Memory configurations

The Ampere architecture doubles down on FP32, Tensor, and RT core performance.

have also changed. The 3090 takes over the Titan RTX slot and gets 24GB of memory and a 384-bit bus, for a total bandwidth of 936GB/s. The RTX 3080 has 10GB on a 320-bit bus, for 760GB/s of bandwidth. RTX 3070 is the less impressive solution, matching the previous-generation 2080 down to 2060 Super with “only” 448GB/s. Nvidia has changed other aspects of the architecture to help make better use of the memory bandwidth, however, so raw





FRITZ!Repeater 300



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strong signal



DSL, telephony  
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Easy and flexible  
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Wi-Fi at home is the best! But it's not so great when reception is weak in some rooms. The solution? Mesh networking at home with FRITZ!.

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bandwidth alone doesn't tell the full story.

One new addition is EDR: Error Detection and Replay. This is a cheaper alternative to ECC (Error Correcting Code) and enables the GPU to recover from errors in data transmission. If the memory subsystem detects a transmission error, it simply retries until it succeeds. This potentially allows for higher clocks that actually have lower performance, but it does mean that running close to the limit of the memory won't be as likely to crash on infrequent errors.

While we're on the subject of memory, let's also note that the ROPs (Render Outputs) have been shifted out of the memory controllers and into the GPCs (Graphics Processing Clusters). This provides more flexibility, enabling Nvidia to have 96 ROPs on both the 3070 and 3080 even though the latter has two additional memory chips. That's because the GA102 has up to seven GPCs of 12 SMs (Streaming Multiprocessors) each, and the 3080 has six GPCs enabled. The GA104, meanwhile, has six GPCs of only 8 SMs each.

### Cache, shared memory, PCIe Gen4, and a farewell to SLI

Wrapping up the Ampere architecture, Nvidia also increased cache sizes and added more flexibility to the shared memory, so that it can be configured as varying amounts of L1 cache or shared memory. The L2 cache on the 3080 is 25 percent larger than on the 2080, and the L1 cache and shared memory capacity is 33 percent larger. Both of these changes improve overall memory throughput.

All of the Ampere GPUs are also fully PCIe Gen4 compliant. In practice, it doesn't currently appear to make much difference, especially since the only PCIe Gen4 consumer platforms come from AMD. Intel CPUs are still generally faster for gaming, so until Intel catches up (with Rocket Lake and Alder Lake on desktops), most gamers will still be better off pairing Ampere with a PCIe Gen3 solution.

Finally, Nvidia has all but killed off SLI with Ampere. The RTX 3090 – yes, the \$3,000 GPU – is the only consumer card that will support NVLink and SLI this round. The NVLink bandwidth has been doubled, however, meaning your Turing NVLink connectors are now outdated. So, \$6,000 will get you a pair of 3090 cards with the new



## 8K gaming with DLSS 2.1

Ampere adds support for HDMI 2.1, which provides up to 48Gbps of bandwidth. It also has DisplayPort 1.4a, which only has 32.4Gbps of bandwidth. Neither one has enough bandwidth to do 8K (7680x4320) at 60Hz without compression, but both can use DSC to spit out 8K60 with HDR. That's still four times as many pixels as 4K, which means even on a 3090 it's still going to be a problem. Enter DLSS 2.1.

DLSS 2.0 has three modes: Performance (4x scaling), balanced (3x scaling), and quality (2x scaling). Even with performance mode, DLSS would need to scale a 4K signal to 8K – it could probably do it, but 8K upscaling is going to be more demanding than 4K upscaling. The solution: DLSS 2.1 adds a new ultra-performance mode with 9x scaling. Specifically, for 8K rendering, DLSS ultra performance renders at 2560x1440.

Obviously, upscaling by a factor of nine is not going to result in perfect image quality. But the bigger question is: On an 8K display, could you even tell? As far as bragging rights go, however, an 8K TV with a 3090 GPU has to be at the top of the gaming enthusiast hierarchy.

NVLink... and then you're still dependent on game developers to support SLI.

That's because Nvidia has explicitly made SLI support a developer choice, and as we've seen over the past few years, that means SLI is basically dead. Note that multi-GPU isn't affected, so GPU compute workloads like Folding@Home will be fine.

Pump up the Amperes  
As you can tell with this short – if you can believe that – overview, Ampere is a tour de force for Nvidia. Check out the specs tables, and any enthusiast is likely to start drooling. With Nvidia's cards on the table, we now get to see if AMD can follow suit or maybe even snag a pot or two.

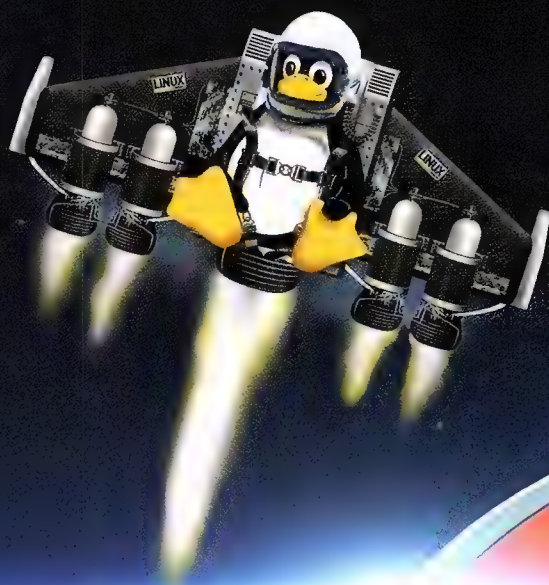
Ultimately, all of these architectural changes only matter so much. Eventually, we need to run games and benchmarks to see how Ampere actually stacks up in

the real world.

We're left wondering where Nvidia will go next. We've known about the Ampere codename since before Turing launched – and in fact, many thought we were getting Ampere two years ago instead of Turing. But looking forward, our crystal ball is very cloudy. We don't know the codename for Nvidia's post-Ampere GPUs. We also don't know what process technology Nvidia will use.

TSMC's N7 might be better than Samsung 8N, but even better than N7 is N7P, N7+, N6 (with EULV), and the new N5 (which just started cranking out Apple's A14 silicon). Will Ampere stick around for two years on 8N, or could it be a shorter-lived architecture, with a die shrink to a more advanced 5nm node? We don't know, but hopefully we don't have to wait two years and add another 100W to find out.





FEATURE

# Ubuntu blast off!

Ubuntu is back and it's better than ever. Read on to find out why Jonni Bidwell is out of this world over this new release.

Canonical's latest Ubuntu release, "Focal Fossa," hit the mirrors earlier this year. So by now thousands of people have downloaded it, installed it and (we'll bet) been downright impressed with what it has to offer. If you haven't yet tried it, then you're in for a treat.

Here we'll show you what's new and what you can do with Canonical's finest. And if you've never tried Linux before, Ubuntu 20.04 LTS is a great place to start. You can try it right now (well, in the time it takes you to download and

write it to a USB stick) without interfering with your current setup. We've got guides to trying out Ubuntu in a virtual machine and, when you feel ready, installing it onto bare metal.

There are all kinds of reasons to switch to Linux, and with the new Ubuntu release comes one more. Be the envy of your proprietary OS-using friends. Never see your computer crippled by updates again. Enjoy a desktop that's not an advertising space. Explore the phenomenal selection of free software,

which more often than not is at least as good as commercial offerings, and in many cases is demonstrably superior. Video editing, 3D modelling, high-powered number crunching and even AAA gaming are all just a few simple clicks away.

If your desktop habits are more sedentary, Ubuntu's got you covered too. Fast web browsing, easy email, and fuss-free media playing are all yours out of the box. Read on to see just how powerful this operating system really is.



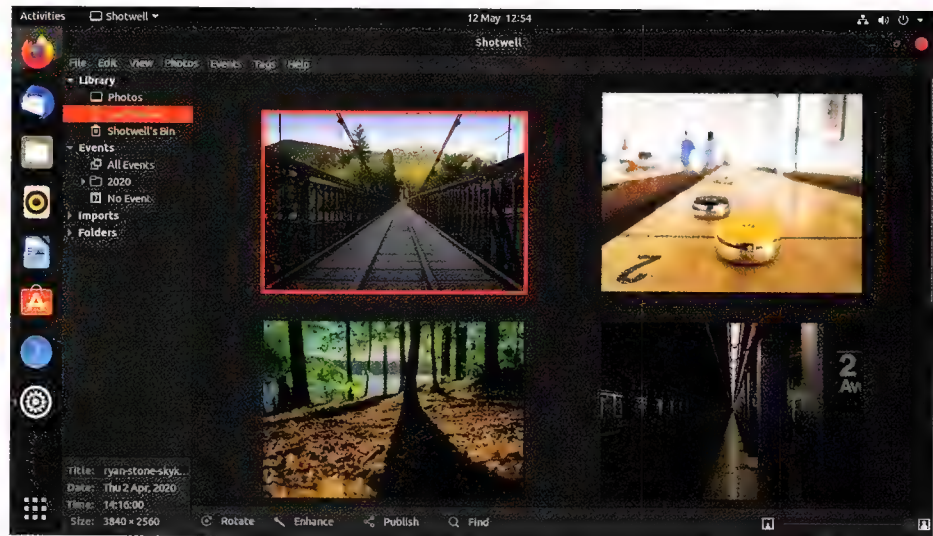
# Focal Fossa Bossa Nova

It's hard to know what to focus on with this new release, so here's a quick summary of Focal Fossa's highlights.

Naturally, everything under the Ubuntu hood has been refreshed. The 5.4 kernel brings support for new hardware and fixes for old. What most home users will be interested in is the desktop, and you'll find that GNOME 3.36 looks and behaves better than ever. It seems like there's been a two-year game of bug whack-a-mole, both within GNOME and Ubuntu's take on it, to address annoying performance and memory issues. But with this release, it's as smooth as the inferior type of peanut butter.

"The darkening" has come finally to Ubuntu. Like so many desktops and programs it now offers a dark mode, which some people find easier on the eyes. Light or dark, we think you'll love the new bold icons and Yaru theme. GNOME's application folders feature – in which you can drag icons in the Applications menu on top of one another to make a folder – is less clumsy now. And if you remove all but one item from a folder, then the singleton is automatically promoted back to the main menu and the folder removed. Tidy.

If you have a HiDPI display you'll be pleased to hear that fractional scaling is finally here. And (unlike in 19.10) you don't need to invoke GSettings from the command line to use it. Previously, only integer scaling was available, which meant users often had to choose between tiny text and giant



text. Now the Goldilocks Zone can be enabled through a simple switch in "Settings>Screen Display," but do note the small print warning about increased power usage and decreased sharpness. At the time of writing, there seems to be issues using this with the proprietary Nvidia driver, so keep an eye on this bug: <http://bit.ly/MPCubuntubug>.

Speaking of Nvidia, its drivers are included on the install medium. No need to resort to a PPA or (shudder) download them from Nvidia's website. Gamers will be pleased to hear that Feral's GameMode is part of a standard install. This can rejig CPU frequency governors, schedulers,

Ubuntu's delightful wallpapers all have a "focal" theme goin' on.

Modern UEFI interfaces should make it easy to change the boot device. This one even makes it possible for you to take screenshots, which is frankly witchcraft.

and other frobs to boost frame rates. And in case you're concerned about the 32-bit library hassle, don't be: Everything needed by Steam, Wine, and Lutris is still in the repos. If you're running old 32-bit applications you might experience difficulties, so test these before getting rid of your 18.04 install. There's an opportunity to help the community here if you find one that doesn't work – do your bit and package it up as a Snap. Learn more from this blog post: <https://snapcraft.io/blog/how-to-preserve-old-software-with-snaps>.

The Ubuntu Software tool now serves Snaps as the default. Indeed, most applications we searched for were only available in this format, but some packages can be installed from the traditional Ubuntu repos. Of course, you can still install packages from the command line with apt if you're not sold on the "app store" mentality. We predict that Snaps (and Flatpaks) are going to gain serious traction in the coming months and years.

As you will see here from the Software application, a number of tools are now packaged as Snaps. And this number will very quickly increase as developers look to side-step the old method of relying on distros to package up their offerings.





# Installing Ubuntu

You've got to try it to love it, but you've got to install it to really feel its power.

Just uttering the phrase "Installing Linux" will send a shiver down the spines of most humans, but it's not as terrifying as it used to be. Don't get overzealous, though: It's still possible to wipe out your existing OS by pushing the wrong button, and you should spend a couple of hours trying out Ubuntu before committing to installing it.

Running the live environment or installing to a virtual machine will give you a handle on the look and feel of this pinnacle of free software. There are a couple of hoops to jump through to get there, though. You can download the Ubuntu install image from whatever operating system you're comfortable with. Fire up your browser, head to [ubuntu.com/download/desktop](http://ubuntu.com/download/desktop) and press the Download button. You can also make a donation to Canonical and choose how the company invests it, but this is optional. You should now have a 2.5GB disk image (ISO) file that you can write to a DVD using the software of your choice (for example, Toast on macOS, CDBurnerXP on Windows, Brasero on Linux). We know that

many PCs and most laptops don't have optical drives nowadays, but that's okay – the image can be written to a USB stick, which will probably boot much faster and certainly will be much quieter than booting from DVD. There are programs like Unetbootin that can automatically download distros and set them up in all kinds of fancy ways, but here we're recommending the cross-platform Etcher tool. Grab it from <https://etcher.io>, start it up, plug in a USB drive (make sure there's nothing precious on it because its contents will all be destroyed), and away you go.

## Boot from your ISO file

You'll need to figure out how to make your PC boot from USB or optical media before you can enjoy Ubuntu. You have two options. One is to open any provided Boot Menu, but not all devices offer this. The key used varies. HP systems use F9, Dell and Lenovo use F12, AMIBIOS-based systems use F8, Award-based systems use F11. You need to slowly tap the key just after

switching on the system. Select any CD-ROM/Optical drive option and you're good to go.

If no boot menu is available the other option is to select the order of boot devices within the BIOS/UEFI settings. A message should appear during the system start saying which key to press. Just as with the boot menu, pressing either Del, F1, F2, Esc or a "special" maintenance key should give access. In the BIOS locate the Boot Device menu and ensure the DVD/optical drive is first in the list. Save and reboot!

You can explore the live environment risk free, but for maximum pleasure and performance install Ubuntu to your hard drive or SSD using the handy six-step guide over the page. If you have one we'd recommend installing Ubuntu to its own device, rather than resizing the Windows partition per steps one and two. It should all work fine, and in fact it's possible to carry out those steps from the Ubuntu installer. But things don't always go as they should, so back up any important data before proceeding. If you have a spare device, just select it and use the Erase disk and install Ubuntu option in step four. If you want to play it safe, another option is to install Ubuntu to a virtual machine using Oracle's VirtualBox.

*"You can explore the live environment risk free, but for maximum pleasure and performance install Ubuntu to your hard drive or SSD."*

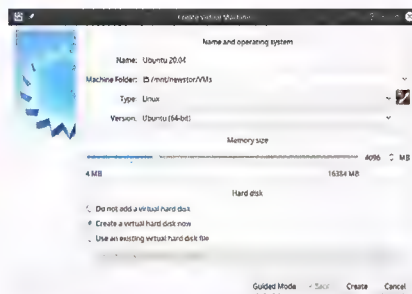


## HOW TO Installing in virtualbox



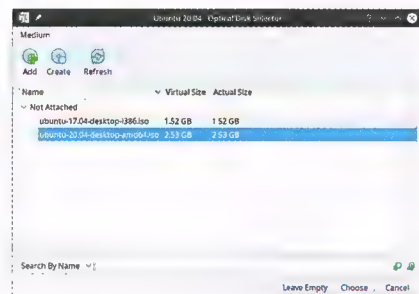
### 01 GET VIRTUALBOX

Head to [www.virtualbox.org](http://www.virtualbox.org) and download VirtualBox 6 for your operating system, be that Windows or OS X. Install it and be aware you'll need at least 20GB of drive space to store the virtual OS file. You'll also need the Ubuntu ISO file from [www.ubuntu.com/desktop/download](http://www.ubuntu.com/desktop/download). Once installed, start it and click the "New" button and call it "Ubuntu."



### 02 CREATE A MACHINE

Choose Ubuntu, and the bits should match the ISO you downloaded, then click "Next." Under Memory we'd recommend 2,048, but if you have an 8GB PC, 4,096 is best. You can leave all the rest as default settings, apart from the dynamic hard drive size. The default is 8GB, but we suggest at least 32GB if you can spare. Finish and click "Start" to get going.

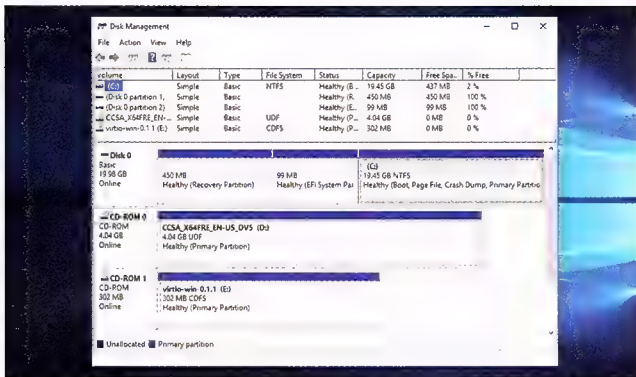


### 03 STARTING VIRTUAL UBUNTU

A prompt will appear asking for a disc – locate the Ubuntu ISO file and click "Start." Linux Ubuntu will start, and once loaded you're free to try out Ubuntu or use the "Install" icon to properly install it to the virtual machine. For extended use, in the virtual machine's settings under "Display," you'll want to enable 3D acceleration and allocate 16MB.

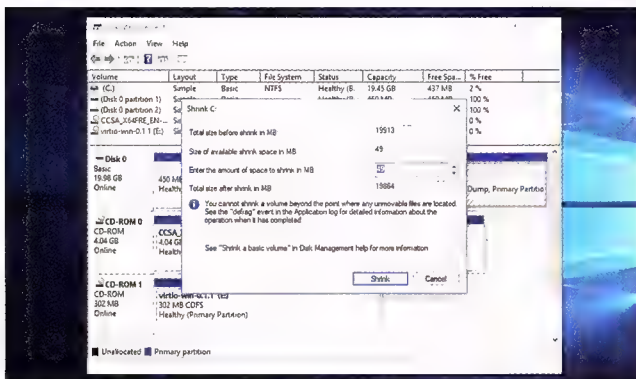


## HOW TO Install Ubuntu with Windows



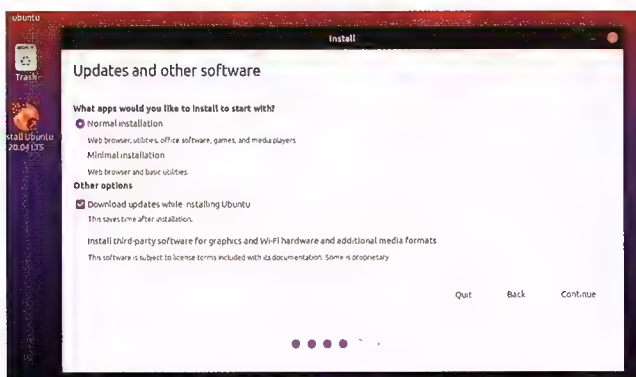
### 01 MAKE ROOM

To create an empty partition for your Ubuntu installation, you'll first have to squeeze your existing Windows partition. Fire up the Disk Management tool in Windows, and right-click your main partition that's typically assigned the drive letter C. Then select the "Shrink Volume" option from the pop-up menu.



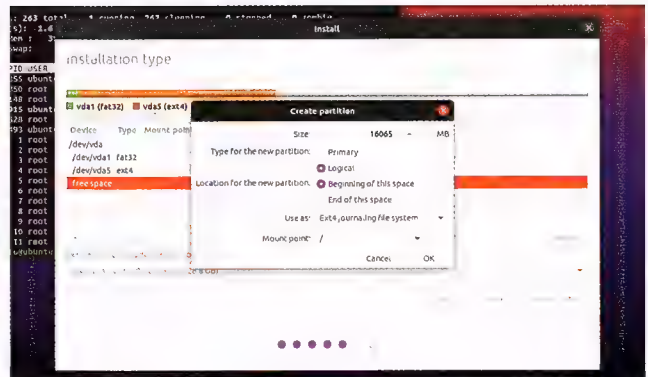
### 03 UPDATES AND PLUGINS

After your computer boots from the Ubuntu installation medium, it will display a checklist. Toggle the two available checkboxes on this screen. The first checkbox option will fetch any available updates from the internet, and the other will install the plugin required to play MP3 content and Wi-Fi firmware.



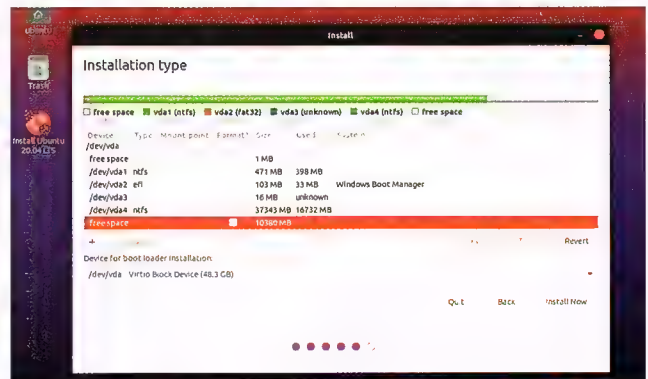
### 05 DEFINE PARTITIONS

In the Create partition box enter the size for the Ubuntu partition. Then use the "Mount point" pull-down menu to select the / option. If you like, you can create a separate home partition (if you want to keep user files and system files separate) in exactly the same way. Just select "/home" from the menu.



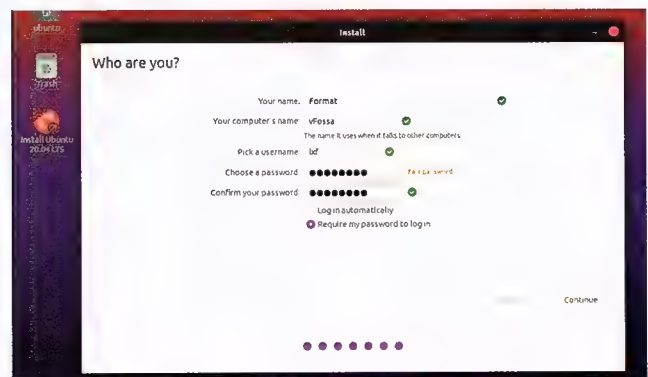
### 02 SHRINK WINDOWS

This brings up the Shrink dialog that shows you the total size of the hard drive and the maximum amount of space that you can squeeze out of the selected partition. To create a new partition, specify the size of the partition in the space provided in megabytes and click "Shrink" to start the process.



### 04 USE FREE SPACE

In the screen labeled "Installation type," toggle the "Something else" radio button to manually partition the disk. Ubuntu will now show you a list of partitions on the hard drive. Select the one labelled "Free Space" and click the plus sign (+) to create a partition out of this space you freed up in Windows.



### 06 LOCALISE AND PERSONALISE

And that's it. The installer will now start the process of installing Ubuntu. While the files are being copied to the hard drive in the background, it'll ask about your locale. In the last screen you'll be asked to enter your desired login and password details, as well as a name for your computer.



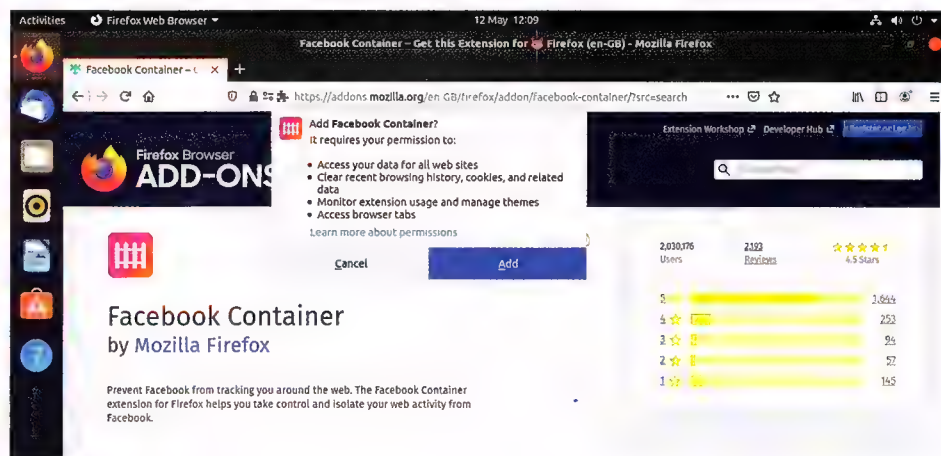
# Desktop deep dive

Here's a quick guide to Ubuntu's top-notch take on the Gnome desktop.

Coming from Windows or macOS, Ubuntu at first glance appears dramatically different. But don't worry, soon it will feel just like home. Your first port of call might be the Applications menu, which you can access by clicking in the top left of the screen, or by pressing the Super (Windows) key. This shows any running applications, or if there aren't any it will show frequently used ones. So the first time you click it this view will be barren. You'll find a grid of installed applications by clicking in the bottom right, so have a nose around to see what interests you.

The standard install includes everything you need to get started, and tries to avoid bundling things that you don't. Perhaps we should have mentioned earlier the minimal install option if you don't need an office suite, games, or other computing fripperies. This saves you around half a gigabyte.

Sooner or later you'll want to add some applications, and the easiest way to do this is through the Ubuntu Software shortcut in the dock (the one that looks like an orange briefcase). One of our first additions is the Gnome Tweaks tool, which makes it possible for you to customise the desktop's appearance and behavior in lots of ways. Depending on who you



believe, this either should not exist at all, or should be included by default on the Gnome desktop. We'll let you be the judge: Just search for "tweak in Ubuntu software," click the green install button, and confirm with your password.

The installer will have prompted you to add any online accounts you have, such as Facebook or Google. These will integrate with your desktop calendar and file manager as appropriate, so you can browse Google Drive or receive Facebook notifications. If you didn't add these accounts earlier you can always add them by going to

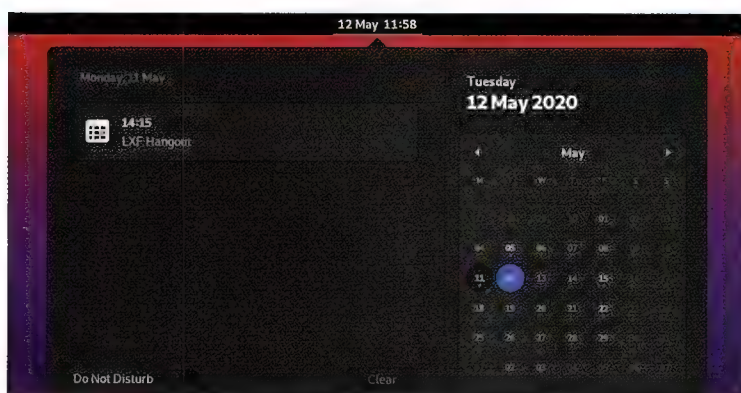
If you can't banish Facebook, you can at least contain it thanks to this excellent Firefox plugin.

## "Settings > Online Accounts."

You'll probably find you need to log out and log back in before calendars and other things sync properly. If you have successfully connected accounts and are tired of all these notifications you can remove them from here too. Alternatively, the "Do Not Disturb" switch in the calendar panel will silence these and hopefully keep you focused.

## Browser wars

We're particularly enamored with Firefox 76 and its stylish new interface. If you're coming from the proprietary world then Google Chrome may be your browser of



The Gnome session lacks Ubuntu's characteristic left sidebar. And the darker colours bring looming deadlines into stark relief.

*"Sooner or later you'll want to add some applications, and the easiest way to do this is through the Ubuntu Software shortcut in the dock (the one that looks like an orange briefcase)."*

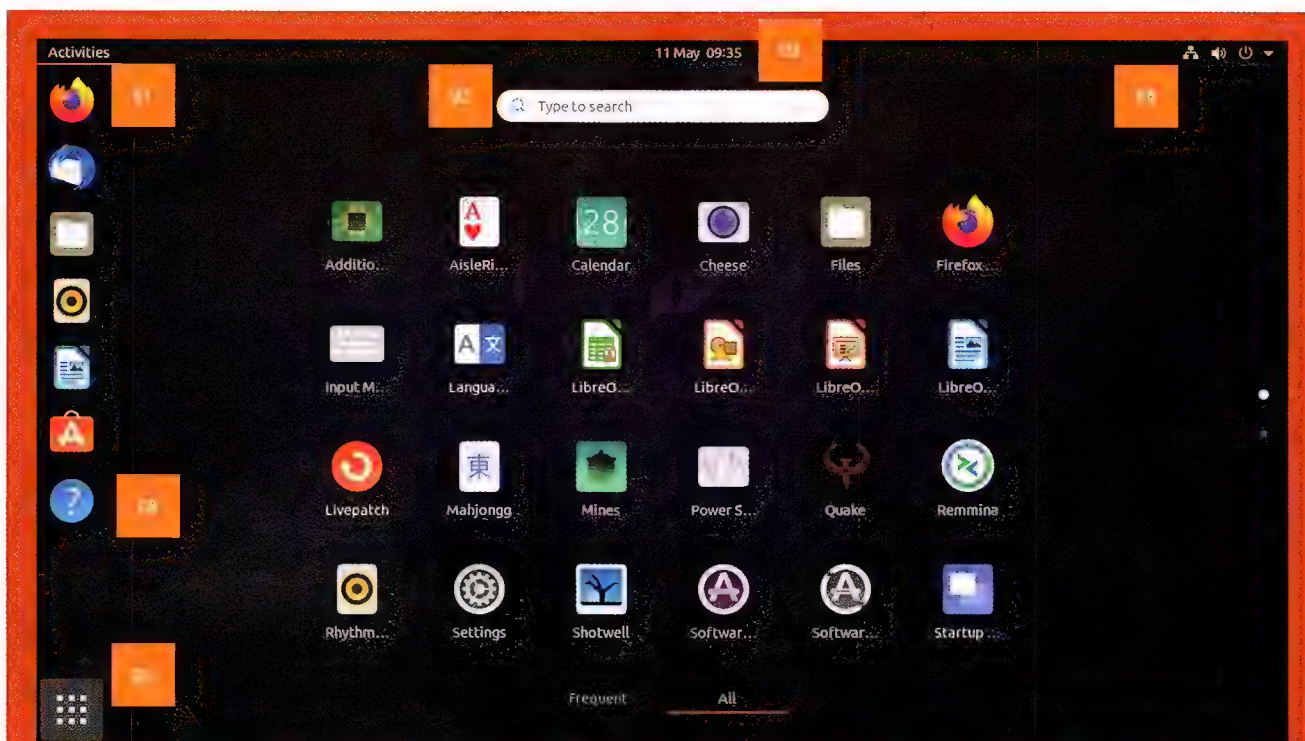
## Favorite flavour

If you don't like Ubuntu's desktop, there are other flavours available. Kubuntu, powered by the slick KDE Plasma desktop, has a slightly more Windows-like feel. Visit <https://ubuntu.com/download/flavours> to see the whole selection. You don't need to install a whole new distro just to try a new desktop, though. For example, if you want to try pure Gnome (without Ubuntu's tweaks) then fire up the Terminal app and type the following:

```
$ sudo apt install ubuntu-gnome-desktop
```

You can then choose the Gnome session from the login screen: Just click the cog icon in the bottom-right and choose Gnome. Unlike the Ubuntu session, this uses the newer Wayland protocol for talking to the displays. This should work well (at least with open-source drivers) by now, but if you run into difficulties try Gnome on Xorg instead. Other desktop environments can be installed this way too, via the **kubuntu-desktop**, **ubuntu-mate-desktop**, **ubuntu-budgie-desktop** and other such packages. Once you've settled on your favorite desktop, you may consider reinstalling the corresponding flavour in the name of tidiness. Each desktop will install its own core applications, so there will be some duplication.





## Getting to Gnome you

### 01 ACTIVITIES

Clicking here (or, alternatively, pressing the Superkey) launches the Activities view. Helpfully, this shows you previews of your running programs on the system.

### 02 SEARCH BOX

Start typing in the Activities view (there is no need to click in the box) to search Apps, Docs and anything else you may need to find.

### 03 CALENDAR AND NOTIFICATIONS AREA

Click here to control music, see any appointments (if you've connected an appropriate service) or activate Do not Disturb mode.

### 04 STATUS MENU

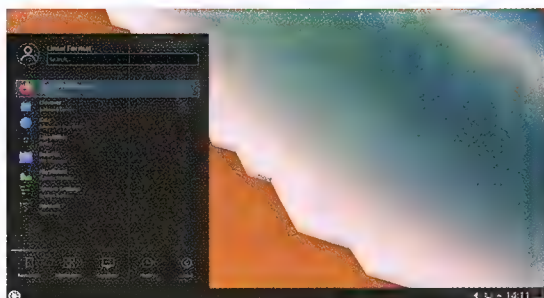
Network settings (including VPN), volume controls, and application indicators can be found here. The button in the bottom left launches the all-important Settings tool.

### 05 APPLICATIONS MENU

Click here to open/close a view of frequently used applications. You can see all installed applications from the selector at the bottom of this menu.

### 06 DOCK

Launch your favourite applications from here. Right-clicking a running application (denoted by a dot) enables you to add it to the dock for easier and more convenient access.



*"If you're coming from the proprietary world then Google Chrome may be your browser of choice, and if you really want that then it's straightforward enough to install."*

choice, and if you really want that then it's straightforward enough to install (and its open-source sibling Chromium is even easier). But we think you should give Firefox a chance, if only for the privacy-preserving Facebook Container add-on. And indeed the multi-account container add-on, because tracking on the web is out of control these days.

Often it's the hate-ridden Windows updates that cause

KDE Plasma is traditional in the sense that there's a menu in the bottom left, but it's sleek and modern looking, too.

people to switch to Linux. Ubuntu is much more considered in its updates. There's an unattended upgrades service that applies urgent fixes in the background, but you'll be told (not forced) about general package updates. These can be applied at a convenient time from the Software application or the command line. Contrary to what you might read elsewhere, it's entirely possible to use desktop Linux without memorising a bunch of strange command line incantations or having a PhD in regular expressions. It's hard to overestimate how powerful the

terminal is, but for desktop use you'd be better off memorising a couple of keyboard shortcuts for Gnome instead:

- Super (Windows key) Bring up the activities view
- Super-Left/Right Tile current application left or right (so it fully occupies one half of the screen)
- Super-Up/Down Maximise/restore current application
- Super-PgUp/PgDown Switch virtual desktops
- Super-Shift-PgUp/Dn Move current application to next/previous virtual desktop.





# Under the hood

There are subtle changes and understated improvements in Ubuntu 20.04 that really deserve mentioning.

We get it. A new Ubuntu release, even an LTS, isn't the cause célèbre it once was. But we've always said that this lack of ground-breaking change is a good thing. It shows that Ubuntu has reached such a level of maturity that refinement, and not radical rewriting of the rules, is the optimal path. We also understand that there are plenty of other distros suitable for beginners (and let's stress here that Ubuntu is popular with professionals too), and maybe some of those don't get the attention that Ubuntu does. All that aside, Ubuntu remains one of the most popular distros among Linux users in general.

In this new outing you'll find support for AMD's Navi 12 and 14 GPUs as well as its new APUs, and the open-source Nouveau driver has improved colour management. There's support for Intel's Comet Lake chips and initial support for its 11th-gen Tiger Lake

architecture. The Kernel Lockdown security module also debuts in this release, which limits userspace code (even if it's running as root) from interfering with kernel operations. First proposed by security guru Matthew Garrett some years ago, this is aimed at admins who want to limit the damage a compromised root account can cause.

There are a couple of noteworthy filesystem changes: Support for Microsoft's newly (sort of) open sourced exFAT, as well as the speedy VirtIO-FS for sharing directories with virtual machines. Ubuntu also backports lots of features from newer kernels, and one notable addition is support for Wireguard VPNs. In an age of surveillance and dubious sponsored "best VPN" listicles, this will surely be a boon for privacy. It's early days yet, but we foresee Wireguard being key to

demystifying the VPN sphere. It's small, fast and much easier to get your head around than OpenVPN, being much more akin to setting up an SSH server.

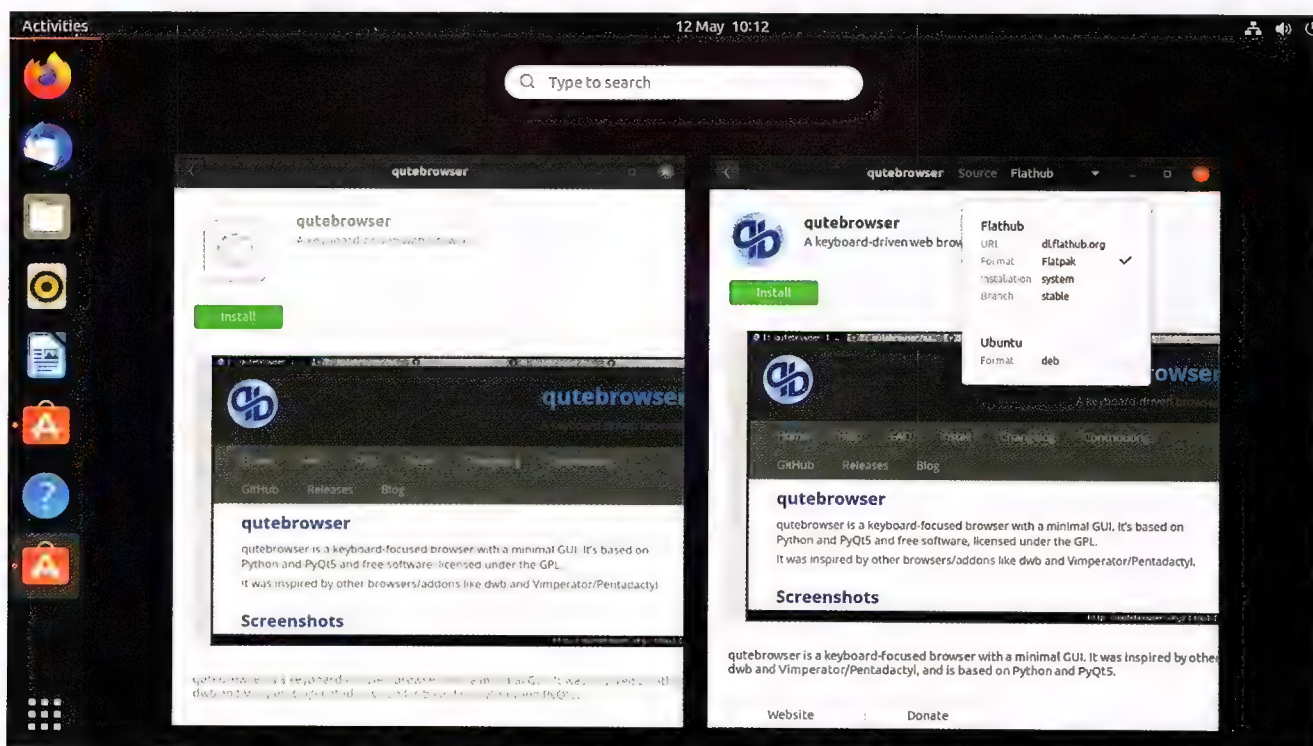
## Storage options

Moving into lower userspace, there's systemd 245, which features the new home directory regime `systemd-homed`. Don't worry though, Ubuntu doesn't use this by default, and to be honest we weren't able to activate it so it looks like this feature hasn't been built into the package. Again, early days. There's also an experimental option to install using the next-generation ZFS filesystem, whose roots go back to Oracle's Solaris. Licencing conflicts have kept this out of the Linux kernel, and it's not a thing your average user will want. But if you have insane storage, lots of memory, and deduplication requirements, ZFS is a mere checkbox in the installer away. Ubuntu's `zsys` middleware will automatically snapshot filesystems before software updates, so they can be undone if things go south.

There's a new, officially supported target to get excited about, the Raspberry Pi (models 2,

*"We've always said that this lack of ground-breaking change is a good thing. It shows that Ubuntu has reached such a level of maturity that refinement, and not radical rewriting of the rules, is the optimal path"*

Two software tools, both alike in dignity in fair Ubuntu where we lay our scene.





3, and 4). Not only is this great for home users, particularly those who want to take advantage of the Pi 3 and 4's Aarch64/ARMv8 OS hardware, but having Canonical's certification will encourage enterprises to do great things with the Pi. Read more about this on Rhys Davies's post on the official Ubuntu blog at <https://ubuntu.com/blog/ubuntu-20-04-lts-is-certified-for-the-raspberry-pi>.

The certification only applies to Ubuntu Server, and that's the only Raspberry Pi download that's offered through Canonical's website, but it's straightforward to add a desktop, for example, via the xubuntu-desktop package. If you have a Pi 4 and want to take advantage of its extra oomph, why not install KDE Plasma? At the moment the official Gnome desktop isn't supported on the Pi, but don't forget an Ubuntu MATE SD card image is available (from <https://ubuntu-mate.org>) if you want a ready-to-roll desktop. The MATE desktop is ideal for lower-powered devices, or just people who liked Gnome 2. MATE images are also available for UMPCs such as the GPD Pocket and MicroPC.

Flatpaks can't be installed from the Ubuntu Software app, but are available from the command line. If you want to install them GUI style you can install the vanilla Gnome Software application, add the Flatpak plugin, and then add the Flathub repo with:

```
$ sudo apt install gnome-software gnome-software-plugin-flatpak
```

```
$ flatpak remote-add --if-not-exists flathub https://flathub.org/repo/flathub.flatpakrepo
```

Note the message about the search path: A restart is required before Flatpak apps show up in the applications menu. Slightly confusingly, you'll now find two app stores, Ubuntu Software and Software, in the applications menu. The latter will enable you to install from the whole gamut of package sources: Flatpaks, Snaps or good old-fashioned DEBs. So you could even uninstall the snap-store package if you want. The screenshot (left) shows the differences between the Snap and Flatpak versions of Qutebrowser.



Get your hardware secured: Elliptic Curve DSA SSH key game on with OpenSSH 8.2.

As for security features there are a few things you can do with hardware tokens such as the Nitrokey and Yubikey. If you have a FIDO (Fast IDentity Online) or U2F (Universal second Factor) device, then not only can you use it to log in locally (using the pam\_u2f module), you can also use it remotely. New key types introduced in OpenSSH 8.2 can work with these devices, enhancing security when logging in to your Ubuntu device via SSH. You might already be familiar with the idea of using an SSH key instead of (or as well as) a password. Basically, generate a key on the local system with `ssh-keygen` then copy it to the remote one with `ssh-copy-id`. Well now, if you attach your hardware token and run

```
$ ssh-keygen -t ecdsa-sk
you'll be prompted to tap the authenticator as well as provide an optional password. You can then copy this key to remote systems as before. In order to log in with the new key, for now, you'll need to specify it with the following:
```

```
$ ssh -i ~/.ssh/id_ecdsa_sk myserver.com
```

### That's all folks

We haven't covered running Ubuntu on Windows via WSL, but with WSL 2 going mainstream soon, that certainly will be an interesting endeavor, though perhaps one that interests developers more than home users. If you're running Ubuntu 18.04 on your server, it's probably wise to go for the 20.04.1 point release. ■

## Out with the old

32-bit PC users won't be able to enjoy this new release. There's no upgrade path from 32-bit 18.04, as there was from 16.04 – the last LTS to offer a 32-bit install medium. And that's a bit of a shame because it's great. But those users can continue to use 18.04 for another three years, so no need to panic yet. Also gone from the default install is Python 2, and the vast majority of packages in the repositories have been upgraded to use Python 3. The older version reached end-of-life at the start of this year, but the package is still available for the few projects that still rely on it.

Finally, a small thing, but one that makes us incredibly happy. That horrible Amazon link in the launcher has gone. It has irked us since it debuted in 2012. The only thing it was useful for was teaching users how to remove icons from the dock. Veterans will recall that previous Ubuntu releases included Amazon links when searching in the Unity HUD, but those days are long gone. Speaking of Unity, if you really miss that desktop, you can install it from the `ubuntu-unity-desktop` package. Alternatively, you can go all out and try the Unity remix. Find out more about this at <https://discourse.ubuntu.com/t/ubuntu-unity-remix-20-04>.

pythonclock.org

## Python 2.7 will retire in...

0 Years 0 Months 0 Days 0 Hours 0 Minutes 0 Seconds

### What's all this, then?

Python 2.7 will not be maintained past 2020. Originally, there was no official date. Recently, that date has been updated to January 1, 2020. This clock has been updated accordingly. My original idea was to throw a Python 2 Celebration of Life party at PyCon 2020, to celebrate everything Python 2 did for us. That idea still stands. (If this sounds interesting to you, email [pythonclockorg@gmail.com](mailto:pythonclockorg@gmail.com)).

Python 2, thank you for your years of faithful service.

Python 3, your time is now.

Python 2 has left the island, and onwards to Python 3 we go.



# System news

Mark Williams looks at the ongoing GPU shortage saga with fresh new competition.

The launch of Nvidia's RTX 3000 series of graphics cards has been quite disastrous from a buyer's perspective, as stocks of any RTX 3000 series cards have been next to impossible to buy as there's simply so much demand for new GPUs at the moment. So much so that even three months after launch, they are all still sold out.

The RTX 3090 appears to be the exception currently, with some stock starting to show as available, although given the asking price for them it is no wonder they're not selling out. They are quite the rip-off at around \$3,000 each, while only offering a ten percent gaming performance improvement over the \$1,400 RTX 3080. That's right, over double the price for just a ten percent uplift.

It was hoped that AMD would save the market with the launch of its RX 6000 series graphics cards by helping to satiate the market demand. While they impressed performance wise, with the RX 6800XT trading blows with the RTX 3080 and the RX 6800 handily beating the RTX 3070 and both XT and non-XT models coming in around \$350 and \$50 cheaper respectively than their closest Nvidia competition, it is at least keeping Nvidia's crazy high prices in check, but are unfortunately still falling short on the supply front with all stocks also sold out at the time of writing.

Although this is just the initial RX 6000 launch phase with AMD reference designs only having been released.

Richard from Aftershock PC told us that only thirty AMD RX 6000 cards have come into Australia in total at the time of writing, which is much worse than the RTX 3000 series launches! However, third party Add-In Board partners like Asus, Sapphire, Gigabyte and the like will launch their own custom models in early December, and we certainly hope that means more availability will come to market before the Christmas period, however Richard suspects even those too will remain out of stock into the new year.

The RX 6900XT will launch around the same time to take on Nvidia's RTX 3090, and word is it'll be far more modest in its asking price and likely still trade blows



**MARK WILLIAMS**  
Mark is an IT professional with a strong interest in voiding warranties.

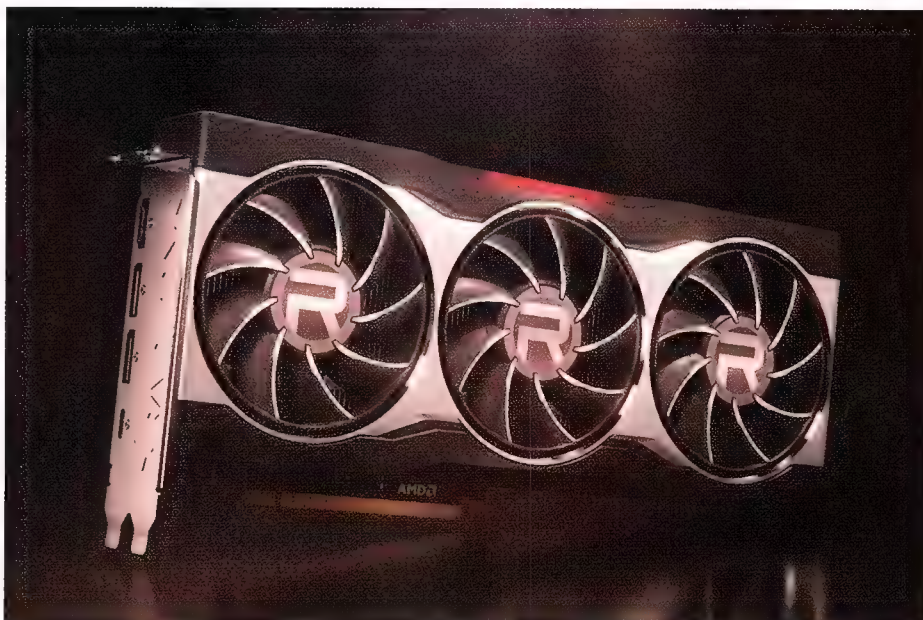
with its competition in performance.

Word is going around that Nvidia has been caught off guard with how competitive AMD's 6000 series is, both in performance and price, and is apparently holding back GPU stocks for a reconfiguration of its product stack with an RTX 3080 Ti (think almost 3090 performance but with 20GB VRAM for much less cost) and a 3070 Ti are both allegedly in the works to better re-align against AMD's new offerings.

It ultimately might not matter what the performance and prices are for each product, at least for now. Normally pricing reflects very closely the relative performance of

each graphics card. And while it seems at the moment that AMD's RX 6000 series is offering above-average performance for the price, Nvidia can and will charge whatever it likes for its cards as they will get snapped up anyway, such is the demand at the moment.

While it's an interesting and exciting time in the graphics card space, we're all held hostage by the supply constraints and market demands and won't fully be able to see proper pricing competition until well into 2021, a year when Intel will burst into the discrete GPU market with its new Xe-based offering. That's when things will really heat up and get interesting.



## Shop talk

How is the launch of the RX 6000 series shaping up for you relative to the RTX 3000 series? How is availability looking, and is demand for the RX 6000 series just as strong?



**RICHARD, AFTERSHOCK PC:**

"At the moment supply seems to be pretty much non-existent for the RX 6000 series. We have already been told that if we want stock, we will need to buy big bundles of 5600XT and 5700XT cards to get them.

I would say the hype and demand for the RTX 3000 series was quite a bit stronger, and with people getting used to no supply of GPUs and Ryzen CPUs, they aren't getting their hopes up for much or any stock around for quite a while yet.

We haven't received any stock of the RX6000 yet. With the 3080 launch we had received quite a bit of stock by this equivalent point in time so that is not a good sign for availability. I believe there were a total of only 30 AMD brand RX6000 cards that came into Australia for the launch (which is better than Singapore which didn't get a single one...). The rest will be AIB cards which we are expecting in the next week or so. I think the AIB models will remain out of stock until next year (but let's hope I'm wrong)." ■



# Market snapshot

An overview of typical systems in today's market.



\$1,798 | [tinyurl.com/APC489JWC](https://tinyurl.com/APC489JWC)

## JW Computers GMR Infinity 5600XT

This system is rather special – it comes with a Chinese market-only CPU! Quite how JW Computers has gotten its hands-on stock is a mystery, but what it does allow for is R5 3600 levels of gaming performance at a low price. Paired with an RX 5600XT, this system is set for RTX 2060 levels of gaming performance without breaking the bank.

The sole 500GB SSD could be a limiting factor for some people longer term. The B450 motherboard while ageing, is still relevant with Ryzen 5000 series CPU support coming via a BIOS update, meaning there is plenty of upgrade paths available in the future if needed. For a system focused solely on gaming, this price is hard to beat and looks great too.

**CPU:** AMD Ryzen 5 3500X, **Cooler:** OEM, **Motherboard:** AMD B450 chipset based, **Graphics:** AMD Radeon RX 5600 XT, **Memory:** 16GB DDR4 3200 RGB, **Storage:** 500GB M.2 NVMe SSD, **PSU:** 650W, **Case:** InWin 805 Infinity RGB



\$1,970 | [tinyurl.com/APC489PLE](https://tinyurl.com/APC489PLE)

## PLE Computers GEN10 Optic

Pricy and underpowered is the simple way of describing this system. It all starts with the CPU, the i5-10400. With 6-cores and 12-threads it has the basic raw performance for today's games sorted but being clocked at a (for Intel) lowly 4.3GHz and having a locked multiplier and only 2666MHz RAM support. Paired with it is a more entry level gaming graphics card, and looking at the asking price relative to the better performing and cheaper JW system, it is awfully hard to recommend this system. A non-OEM cooling solution is provided for some reason. Given the lack of clock speeds and overclocking it is wasted money in this build. Given the RAM, motherboard and the other components, these specs will not age well. Avoid.

**CPU:** Intel Core i5 10400, **Cooler:** ID-Cooling SE-224-XT RGB, **Motherboard:** Gigabyte B460M DS3H AC, **Graphics:** Gigabyte GeForce GTX1660Ti, **Memory:** Gell 16GB DDR4 Super Luce 2666MHz, **Storage:** Samsung 860 EVO 250GB SSD, WD Blue 1TB HDD, **PSU:** eVGA GD Series 600W, **Case:** Jonsbo U5 Black



\$2,867 | [tinyurl.com/APC489AFT](https://tinyurl.com/APC489AFT)

## Aftershock BFCM

This is about what to expect for the year ahead as the new gaming middle ground for performance. The Ryzen 5 5600X is for now the new gaming king, besting in most cases any Intel offering in gaming while costing a fraction of the price and is the main reason this system scrapes in under \$3,000.

The RTX 3070, in a similar vein, is also solid without breaking the bank and will offer solid mid-high fps 1440p performance and even some 4K dabbling with DLSS usage. Mass storage capacities are good, and the liquid cooling should allow the 5600X to be the best it can. Great to see the memory clocked at 3600MHz, though CL18 timings is unimpressive. This is the new sweet spot in gaming rigs, what a start to 2021!

**CPU:** AMD Ryzen 5 5600X, **Cooler:** Aftershock Spectra Glacier 240mm, **Motherboard:** Asus B550 TUF Plus Gaming, **Graphics:** Gigabyte Gaming RTX 3070 OC, **Memory:** 16GB DDR4 3600MHz Gigabyte Aorus CL18, **Storage:** 1TB NVMe GEN4 SSD, 2TB Seagate BarraCuda 7200RPM HDD, **PSU:** FSP 650W, **Case:** Deepcool Matrexx 50

\$3,599 | [tinyurl.com/APC489PCC](https://tinyurl.com/APC489PCC)

## PC Case Gear Strike 6800

For the more demanding gamer, this system offers performance above the sweet spot with a price to match. The 8-core Ryzen 5800X is the worst value of the 5000 series CPUs, as it's too closely priced to the generally better 5900X, but, with its golden sample CCD layout found in the 5950X it may actually net you better performance in certain circumstances. The RX 6800 is also a great price to performance choice here and sits not all that far away from the likes of an RTX 3080 and is well suited to high fps 1440p gaming. 32GB of RAM paired with the 8-core CPU and reasonable mass storage space makes for a system that is well suited to some occasional heavy productivity work in between gaming sessions.

**CPU:** AMD Ryzen 7 5800X, **Cooler:** Cooler Master MasterLiquid ML240R ARGB AIO, **Motherboard:** Asus ROG Strix X570-F Gaming, **Graphics:** PowerColor Radeon RX 6800 16GB, **Memory:** Corsair Vengeance RGB Pro 32GB 3600MHz CL18 DDR4, **Storage:** Adata XPG SX8200 Pro M.2 NVMe SSD 1TB, Seagate, Barracuda 2TB HDD, **PSU:** Super Flower Leadex III Gold 750W, **Case:** Phanteks Eclipse P400A Airflow Plus





PC BUILDER

# Budget

Punching above its price.

With the builds well and truly shaken up last issue, it's now time to introduce some new cases. The Intel and AMD builds at each price range will still share the same case, and for our budget systems it's the simple but effective Corsair 4000D Airflow.

Following last month's changes, we're now focused on trimming the price and making small improvements. Multiple price drops on components in both builds (CPUs, our power supply, and the Asrock motherboard in the AMD build) have given us a bit of money to play with, but we're keeping it sensible. A motherboard shift from Gigabyte to Asrock in the Intel build helps us make a further saving, and both builds have new memory: Ripjaws Series V in the AMD machine, and TeamGroup T-Force Dark Z in the Intel one. We've dialed the memory speed in the Intel machine back to 3,200MHz; if you can find a cheaper DDR4-3600 kit then great, but the Core i5-10400 won't benefit as much from the higher speed compared to the Ryzen.

Our GPUs have had a swap; the AMD RX 5500 XT 4GB card is back in the AMD build, although it's a different (read: cheaper) model from XFX this time. The Intel build also has a more affordable GPU, MSI's Ventus XS version of the GTX 1650 Super. These two cards

should have near-identical performance, averaging around 60fps at 1080p Ultra – thanks to Jarred as always for the numbers.

The last adjustment we've made is to the drives. 250GB isn't bad, but 500GB is better, and we've doubled our SSD storage without much price alteration. Gigabyte's Aorus Gen4 500GB SSD will give

us glorious PCIe 4.0 speeds for less than the 250GB Samsung 980 Pro drive we used last month, making it a no-brainer, even if it won't perform quite as well as Samsung's pricier SSD. Meanwhile, we've taken our savings in the Intel build and converted it into storage, springing for the 500GB Crucial P1 M.2 drive.

*"Following last month's changes, we're now focused on trimming the price and making small improvements. Multiple price drops on components in both builds (CPUs, our power supply, and the Asrock motherboard in the AMD build) have given us a bit of money to play with, but we're keeping it sensible."*

## AMD INGREDIENTS

| PART    |                                                               | PRICE   |
|---------|---------------------------------------------------------------|---------|
| CASE    | CORSAIR 4000D AIRFLOW <b>NEW</b>                              | \$129   |
| PSU     | 450W GIGABYTE GP-450B 80+ BRONZE                              | \$59    |
| M/BOARD | ASROCK B550M PRO4                                             | \$169   |
| CPU     | AMD RYZEN 3 3100                                              | \$169   |
| GPU     | XFX RADEON RX 5500 XT 4GB <b>NEW</b>                          | \$299   |
| RAM     | 16GB (2 X 8GB) G.SKILL RIPJAWS V SERIES @ 3,600MHZ <b>NEW</b> | \$129   |
| SSD     | 500GB GIGABYTE AORUS M.2 PCIE 4.0 SSD <b>NEW</b>              | \$169   |
| HDD     | 1TB SEAGATE BARRACUDA HDD                                     | \$65    |
| OS      | WINDOWS 10 HOME 64-BIT OEM                                    | \$60    |
| PRICE:  |                                                               | \$1,248 |

## INTEL INGREDIENTS

| PART    |                                                               | PRICE   |
|---------|---------------------------------------------------------------|---------|
| CASE    | CORSAIR 4000D AIRFLOW <b>NEW</b>                              | \$129   |
| PSU     | 450W GIGABYTE GP-450B 80+ BRONZE                              | \$59    |
| M/BOARD | ASROCK B460M PRO4 <b>NEW</b>                                  | \$139   |
| CPU     | INTEL CORE I5-10400                                           | \$279   |
| GPU     | MSI GEFORCE GTX 1650 SUPER VENTUS XS OC 4GB <b>NEW</b>        | \$239   |
| RAM     | 16GB (2 X 8GB) TEAMGROUP T-FORCE DARK Z @ 3,200MHZ <b>NEW</b> | \$99    |
| SSD     | 500GB CRUCIAL P1 M.2 PCIE 3.0 SSD <b>NEW</b>                  | \$80    |
| HDD     | 1TB SEAGATE BARRACUDA HDD                                     | \$65    |
| OS      | WINDOWS 10 HOME 64-BIT OEM                                    | \$60    |
| PRICE:  |                                                               | \$1,159 |





PC BUILDER

# Mid-range

PCs for most of us.

Our new case for the mid-range builds is the PCO11-Dynamic from Lian Li, a sleek dual-chambered chassis with tempered-glass windows and tons of space. Lian Li has always been a high-quality choice when it comes to PC cases, and the PCO11-Dynamic is no exception. We've also got a new PSU for the Intel build, the MasterWatt 650, to provide a little choice when it comes to powering systems. Either power supply's fine for our builds here.

Both machines are getting a new cooler, the dual-fan A500 from Corsair (also seen in this issue's build feature). It's a beefy (but not too noisy) air cooler with swappable brackets that make it compatible with both AM4 and LGA 1200 CPU sockets. We looked into replacing the GPU these two machines share, but it's dropped in price since we last looked, and the next step up in performance would be to a pricier RTX 2060 Super or RX 5700 XT.

In the AMD machine, there's going to be a different processor

sitting beneath that cooler. It's a very slight shift made to accommodate dwindling stock of the Ryzen 5 3600X at the time of writing, and we've gone for the cream-of-the-crop 3600XT. It actually costs the same as the 3600X did last month, and while the performance difference is only between one and five percent in practical tests, it's definitely still the superior chip.

In our Intel build, we've got the same CPU but a new motherboard:

The MSI MPG Z490 Gaming Plus. It's a versatile and reasonably priced mobo, with USB-C Gen 3.2 and 2.5G LAN, and MSI's Mystic Light RGB lighting. Speaking of which, although the Trident Z RGB we used here last issue has leapt up in price, we don't want to leave you colourless. To retain lighting and performance with only a minor price increase, we've swapped it out for a 16GB kit of TeamGroup's T-Force Delta RGB memory, at the same 3,200MHz frequency.



## AMD INGREDIENTS

| PART    |                                                               | PRICE   |
|---------|---------------------------------------------------------------|---------|
| CASE    | LIAN LI PCO11-DYNAMIC <b>NEW</b>                              | \$229   |
| PSU     | 650W CORSAIR CX650                                            | \$139   |
| M/BOARD | ASUS TUF GAMING X570-PLUS                                     | \$349   |
| CPU     | AMD RYZEN 5 3600XT <b>NEW</b>                                 | \$389   |
| COOLER  | CORSAIR A500 <b>NEW</b>                                       | \$159   |
| GPU     | MSI RADEON RX 5700 MECH GP OC 8GB                             | \$609   |
| RAM     | 16GB (2 X 8GB) G.SKILL RIPJAWS V SERIES @ 3,600MHZ <b>NEW</b> | \$139   |
| SSD     | 500GB GIGABYTE AORUS GEN4 M.2 PCIE 4.0                        | \$169   |
| HDD     | 1TB SEAGATE BARRACUDA HDD                                     | \$65    |
| OS      | WINDOWS 10 HOME 64-BIT OEM                                    | \$60    |
| PRICE:  |                                                               | \$2,307 |

## INTEL INGREDIENTS

| PART    |                                                            | PRICE   |
|---------|------------------------------------------------------------|---------|
| CASE    | LIAN LI PCO11-DYNAMIC <b>NEW</b>                           | \$229   |
| PSU     | 650W COOLER MASTER MASTERWATT 650 <b>NEW</b>               | \$109   |
| M/BOARD | MSI MPG Z490 GAMING PLUS <b>NEW</b>                        | \$289   |
| CPU     | INTEL CORE I7-10700                                        | \$589   |
| COOLER  | CORSAIR A500 <b>NEW</b>                                    | \$159   |
| GPU     | MSI RADEON RX 5700 MECH GP OC 8GB                          | \$609   |
| RAM     | 16GB (2 X 8GB) TEAM T-FORCE DELTA RGB @ 3200MHZ <b>NEW</b> | \$109   |
| SSD     | 500GB WD BLACK SN750 M.2 PCIE 3.0                          | \$130   |
| HDD     | 1TB SEAGATE BARRACUDA HDD                                  | \$65    |
| OS      | WINDOWS 10 HOME 64-BIT OEM                                 | \$60    |
| PRICE:  |                                                            | \$2,348 |



PC BUILDER

# Turbo

Maximum overkill.

Among other changes, we've upgraded the Intel system's motherboard and cooler. For the board, we've got the Asus TUF Gaming Z490-Plus WiFi, a gaming-oriented motherboard that uses Asus GameFirst VI, an AI-assisted feature that automatically optimises network bandwidth usage to minimise lag spikes in online games. The new cooler is Nzxt's excellent Kraken X63, a twin-fan AIO cooler with a seriously cool RGB-lit infinity mirror cap on the pump block.

The AMD system gets a new motherboard too, from MSI: The X570 Gaming Pro Carbon WiFi. The other changes here are present in both builds, the reason for which will become clear as you read on.

First up is the memory. We found a fresh kit for the AMD build first, a 2x16GB Corsair Vengeance RGB Pro at 3,600MHz with slick RGB lighting. It's a solid choice for any high-end machine, and it's only \$239 – an absolute steal. It got us thinking: The Intel machine doesn't really need memory that fast, since only AMD chips benefit significantly from higher speeds due to how memory interacts with the Infinity Fabric in Ryzen chips. But



why shouldn't we use that same kit in our Intel Turbo machine? It's excellent value and is sure to perform great. It's only marginally more expensive than a 3,200 or 3,000MHz kit, and works to better future-proof your PC as available memory speeds get faster and faster.

The other component that you can see here in both builds is, of course, the GPU. At the time of

writing, RTX 3080 cards are still in high demand, and one of the few we could find at a reasonable price was Gigabyte's Eagle model. Hopefully by the time this issue is in your hands, stocks will have replenished somewhat, and those among you with their sights set on a major upgrade will be able to snap up one of these new cards. Or perhaps Radeon RX 6000 will be the next big thing...

## AMD INGREDIENTS

| PART    |                                                                | PRICE   |
|---------|----------------------------------------------------------------|---------|
| CASE    | PHANTEKS ENTHOO PRO 2 TEMPERED GLASS <b>NEW</b>                | \$219   |
| PSU     | 750W CORSAIR RM750X MODULAR PSU                                | \$199   |
| M/BOARD | MSI MPG X570 GAMING WIFI <b>NEW</b>                            | \$320   |
| CPU     | AMD RYZEN 9 3950X                                              | \$1,149 |
| COOLER  | CORSAIR ICUE H115I RGB PRO XT 280MM                            | \$259   |
| GPU     | GIGABYTE GEFORCE RTX 3080 EAGLE 10G <b>NEW</b>                 | \$1,399 |
| RAM     | 32GB (2 X 16GB) CORSAIR VENGEANCE RGB PRO @ 3600MHZ <b>NEW</b> | \$239   |
| SSD     | 1TB FIRECUDA 520 M.2 PCIE 4.0 SSD <b>NEW</b>                   | \$320   |
| HDD     | 6TB SEAGATE BARRACUDA HDD                                      | \$250   |
| OS      | WINDOWS 10 HOME 64-BIT OEM                                     | \$60    |
| PRICE:  |                                                                | \$4,414 |

## INTEL INGREDIENTS

| PART    |                                                                | PRICE   |
|---------|----------------------------------------------------------------|---------|
| CASE    | PHANTEKS ENTHOO PRO 2 TEMPERED GLASS <b>NEW</b>                | \$219   |
| PSU     | 850W NZXT C850                                                 | \$195   |
| M/BOARD | ASUS TUF GAMING Z490-PLUS WIFI <b>NEW</b>                      | \$369   |
| CPU     | INTEL CORE I9-10900K                                           | \$999   |
| COOLER  | NZXT KRAKEN X63 280MM <b>NEW</b>                               | \$249   |
| GPU     | GIGABYTE GEFORCE RTX 3080 EAGLE 10G <b>NEW</b>                 | \$1,399 |
| RAM     | 32GB (2 X 16GB) CORSAIR VENGEANCE RGB PRO @ 3600MHZ <b>NEW</b> | \$239   |
| SSD     | 1TB WD BLACK SN750 M.2 PCIE 3.0                                | \$220   |
| HDD     | 6TB SEAGATE BARRACUDA HDD                                      | \$250   |
| OS      | WINDOWS 10 HOME 64-BIT OEM                                     | \$60    |
| PRICE:  |                                                                | \$4,199 |





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BUILD IT

# Couch Potatoes

As new consoles flood the market, we're building a living room gaming machine, with Christian Guyton.

With Microsoft and Sony facing up for battle, and our living rooms acting as the arena in which the next console war will be fought, the PC is in a strange place. Yes, consoles have their advantages, and we love them dearly (you'll have to pry the Nintendo Switch Lite from our cold, dead hands), but our beloved PCs are only getting better too.

Discrete GPUs are becoming more powerful, and PCs maintain superior flexibility over consoles – we'd like to see an Xbox run the Adobe Creative Suite – and former big exclusives like *Halo* and *Horizon: Zero Dawn* are steadily beginning to make their way over to our desktops.

So, this month we're firing back with a build that can sit under or beside your TV, using a controller or lapboard for a spot of living room gaming. If you build this PC, we want you to be able to put your feet up, pour a tall glass of your beverage of choice, and dive into your Steam library from the comfort of your couch.

Now, we're not going to beat around the bush here: As a consumer building a fresh PC, there's no way to achieve the same price-to-performance ratio as the new consoles. The digital-only Xbox Series S in particular is impossible to match without the same sort of bulk-purchase custom chip deals that Microsoft is able to make. But we're trying to keep the

pricing sensible, and the higher price comes with the ability to upgrade easily down the line.

What we want here is a competent 1080p to 1440p gaming machine, using a compact chassis along with low power consumption and heat generation. Running quiet would be a bonus, but considering how noisy some consoles can get, it's not a primary concern. It should, however, be easy to clean and maintain, so an accessible case is a must-have.

You might be thinking of building this machine not for yourself, but as a stepping stone into the world of PC gaming for someone else in your life. Whether it's a child who has yet to get to grips with a mouse and keyboard, or a partner who prefers couch co-op, this system could offer a gentle introduction to gaming on PC, and should also demonstrate the benefits of a custom-build system.

That means controller compatibility (which we'll get into properly later) and RGB lighting, because we're looking at those shiny new consoles and thinking that we ought to show off a bit too. A simple but attractive aesthetic is what we're aiming for here, with customisable lighting that can be tailored to the user's preferences. Want to know what parts we've picked? Read on...



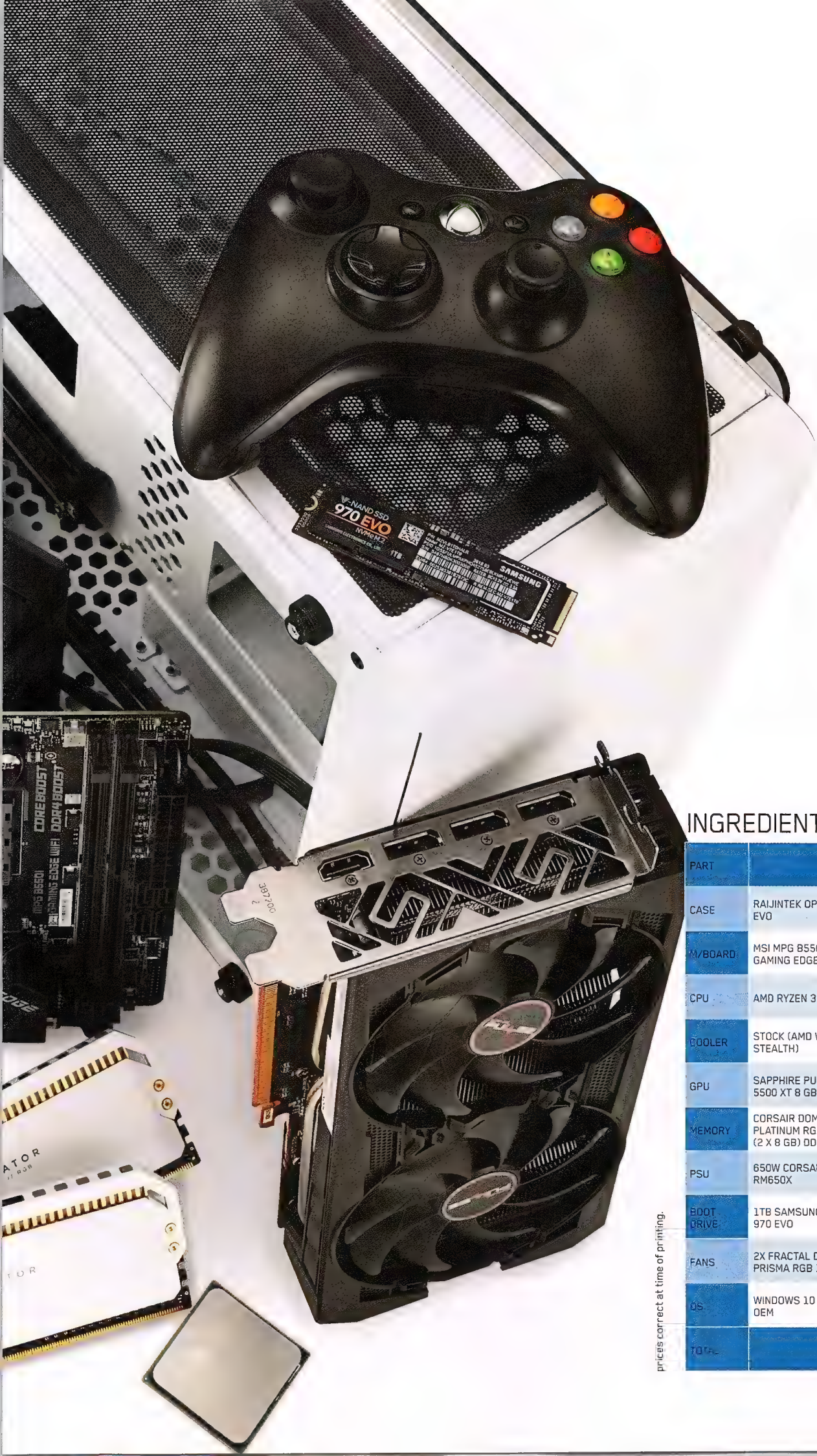
CHRISTIAN GUYTON

Christian likes taking things apart then putting them back together again.

*"What we want here is a competent 1080p to 1440p gaming machine, using a compact chassis along with low power consumption and heat generation. Running quiet would be a bonus, but considering how noisy some consoles can get, it's not a primary concern."*







## INGREDIENTS

| PART       |                                                           | PRICE   |
|------------|-----------------------------------------------------------|---------|
| CASE       | RAIJINTEK OPHION EVO                                      | \$250   |
| M/BOARD    | MSI MPG B550I GAMING EDGE WIFI                            | \$329   |
| CPU        | AMD RYZEN 3 3100                                          | \$169   |
| COOLER     | STOCK (AMD WRAITH STEALTH)                                | \$0     |
| GPU        | SAPPHIRE PULSE RX 5500 XT 8 GB                            | \$299   |
| MEMORY     | CORSAIR DOMINATOR PLATINUM RGB 16 GB (2 X 8 GB) DDR4-3600 | \$220   |
| PSU        | 650W CORSAIR RM650X                                       | \$199   |
| BOOT DRIVE | 1TB SAMSUNG 970 EVO                                       | \$199   |
| FANS       | 2X FRACTAL DESIGN PRISMA RGB 120MM                        | \$90    |
| OS         | WINDOWS 10 HOME OEM                                       | \$60    |
| TOTAL      |                                                           | \$1,866 |

prices correct at time of printing.





# The hardware

## MOTHERBOARD MSI MPG B550I Gaming Edge WiFi

\$329

The new B550 format is, in a word, great. Performance and feature support on ITX boards has never been better, with MSI's Wi-Fi 6-equipped model coming with a fan-powered M.2 heat sink and PCIe 4.0 support. While we're not using a 4th-gen M.2 SSD in this build to keep costs down, the upgrade potential is always there, and this motherboard should provide an excellent base from which to build and improve a system. The product quality is also excellent, with solid thermal solutions and a clean, dark aesthetic. The BIOS is pleasingly simple to navigate, too.



## CASE Raijintek Ophion Evo

\$250

An ITX case that makes excellent use of the available space and still manages to look good? Yes, it's safe to say that we like the Ophion Evo, with its dual glass panels and white aluminum chassis. However! Shortly after we completed this build with this case, availability in Australia practically dried up. We decided to go ahead and share the project with you, as any nice looking ITX case will do the job equally as well. Cases to consider include Nzxt's H210, Lian Li's PC-TU150 Mini or perhaps InWin's lovely A1 Plus Mini. Cougar's \$89 QBX Mini is a bargain choice. These all have similarly appealing aesthetics for the living room.







CPU

## AMD Ryzen 3 3100

\$169

If you're gaming on a budget, the Ryzen 3 3100 is a stellar choice right now. 8 threads and a 3.9MHz boost clock for under 200 dollars makes for a sweet package, and it comes with the respectable AMD Wraith Stealth cooler too. Yes, the slightly more expensive 3300X brings better performance per dollar, but it also runs hotter and uses more power. The 3100 is a lightweight chip that shouldn't struggle with low to mid-range gaming and will help keep system temperatures low. We're not using a 4th-generation M.2 drive in this build, but this chip does have PCIe 4.0 support for any future upgrades.

GPU

## Sapphire Pulse RX 5500 XT 8GB

\$299

This is a sensibly priced GPU that should be able to handle any game at 1080p Ultra settings and some titles at 1440p. As we said, squeezing the same amount of graphical power from a custom PC build is always going to cost more than buying a console, so we've stuck with a relatively conservative choice here. Going with this card gives us access to several handy features like Radeon Anti-Lag and AMD Link - more on that later. The 5500 XT comes in 4GB and 8GB variants; make sure you're getting the 8GB model, as the 4GB version will seriously struggle at 1440p.







Controller  
Xbox 360  
Wireless  
Controller/  
PlayStation  
DualShock 4.

\$89/\$99

Really, you can use whatever control scheme you want with a system like this. We're going to be using a standard DualShock 4 gamepad from Sony, but only because we already have a PS4 knocking about. There are lots of potential options here, most of which are likely to be cheaper. If you don't mind a wired controller, older models like the Xbox 360 gamepad are an option.

Alternatively, the Xbox Elite controller will cost you significantly more but is arguably the best choice for couch gaming on PC. Peripheral brands such as Logitech and Razer have their own 3rd-party offerings, too.

PSU  
650W Corsair  
RM650x 80+ Gold

\$199

A modular power supply is typically a necessity for building in an ITX case, and the Ophion Evo is no exception.

There's little room for cable management here, and the lack of any SATA drives or other accessories means that we're only going to need three power cables: Motherboard ATX, CPU, and PCIe for the GPU. The RM650x's modular design ensures that we can keep this case as tidy as possible, and while it's not the cheapest PSU around, Corsair is a reliable brand, and the 80+ Gold rating will help our system's energy efficiency.



CPU COOLER  
AMD Wraith  
Stealth

\$0

It's hard not to like AMD's Wraith series of coolers. Packaged free with the Ryzen 3 3100 (as they are with most Ryzen chips), the Wraith Stealth is a relatively low-profile and quiet cooler that gets the job done without costing a cent more. The 3100 runs cool, so it doesn't really need a powerful cooler: An AIO unit would probably be overkill here. The Stealth is effective and super-easy to install, making it the obvious choice. If you're planning on overclocking the CPU, you may want a more robust cooler, but this system shouldn't hit high temperatures anyway.





RAM

## Corsair Dominator Platinum RGB 16GB (2 x 8GB) DDR4-3600

\$220

3,600MHz might be overkill, but the higher speed is destined to benefit the lower-end Ryzen 3 3100 processor. 16GB is generally plenty of RAM for modern gaming, and there's potential here to level it up to a 2 x 16GB kit in the future (although it's worth bearing in mind that the MPG B550I Gaming Edge WiFi only has two DIMM slots). Even if it wasn't seriously good memory, the Dominator

Platinum RGB also boasts gorgeous lighting, thanks to 12 individually addressable RGB LEDs per module, fully customizable via Corsair's iCue software.



SSD

## 1TB Samsung 970 Evo

\$199

Another "Evo" component! No relation, we're told. Samsung's 3rd-gen M.2 SSDs are a lot cheaper than they used to be, making the 970 Evo a solid choice for this build. The M.2 format saves us space inside the case (although the Ophion Evo does have room for up to four 2.5-inch SATA drives) and also means we'll need fewer cables, which is ideal in an ITX build. Samsung's drives are reliable and fast, and 1TB should be enough storage to get started with – particularly if this is a build for a PC gaming rookie.

Fans

## 2x Fractal Design Prisma RGB 120mm

\$90

Like many ITX cases, the Ophion Evo doesn't come with any included case fans. It does have a lovely hexagonal grid with a magnetic dust filter running across the roof of the case, though. We're going to be installing two of Fractal Design's 120mm Prisma fans. RGB lighting can be handled by a single header on the motherboard, since the RGB cables on these fans can be easily daisy-chained together. The Prismas are easy to install and throw out plenty of bright rainbow lighting, while the 19.5 decibel sound rating means that this machine should never get too loud.

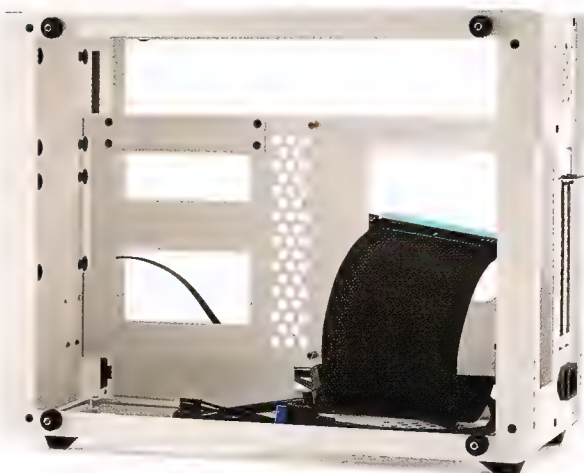




# Little boxes

This should be a straightforward job: clear yourself some building space and have your tools at the ready.

Length of time: 1-2 hours. Level of difficulty: easy



## 01 PREPARE THE CASE

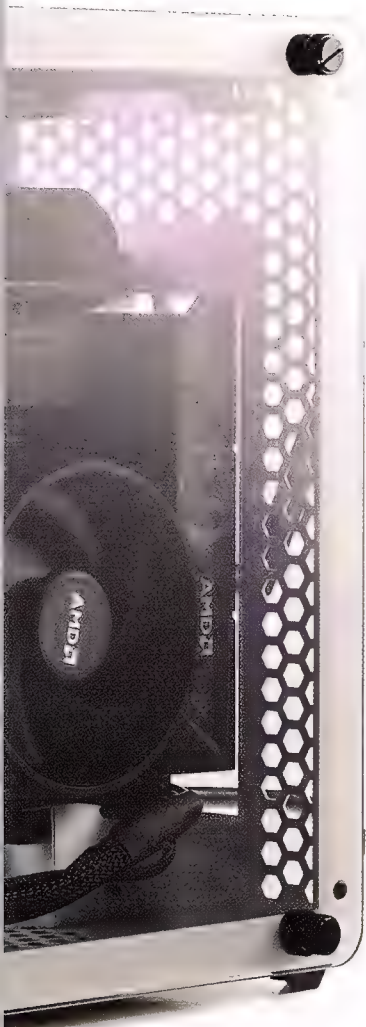
As usual, start the build process with a stripdown of the case. The Raijintek Ophion Evo makes this nice and simple; the only things that really need removing at this stage are the two glass side panels, each of which is secured by four thumbscrews with rubber washers. These side panels are a bit delicate and prone to scratches and fingerprints, so place them back into the case box and leave them until the build is complete. If your Ophion Evo is new, you'll need to extract a few extra bits and pieces, like the accessories bag and plastic cover on the PCIe riser cable. Leave the blue plastic cover on the PCIe connector until you're ready to plug it in: You don't want to damage it. Remove the two magnetic dust filters on the top and bottom of the case exterior. You'll be moving the case a lot during this build, and these filters can slip around.



## 02 ON THE EDGE

The MPG B550I Gaming Edge WiFi is surprisingly heavy considering its diminutive form factor, thanks to the chunky metal heat sinks all over it. Unbox it and place it on an anti-static work surface (using the top of the box is fine). It comes with plastic brackets either side of the CPU socket, which we won't be using but you can leave in place for now. However, remove the large protective sticker on the underside. We'll mount the CPU right away. Unbox it and set the included Wraith Stealth cooler aside for later. Be careful: This may come with a pre-applied lattice of thermal solution, so don't get that all over your fingers. With the CPU in hand, simply lift up the metal retention arm by the side of the socket and drop the chip into place, ensuring that the gold triangle on one corner of the processor lines up with the matching triangle on the socket's outer edge. Once it's in position, lower the retention arm so that it clicks back into place securely.





## Budget conscious

If you really want to trim the fat and build a straightforward console replacement for a console price, you'll first need to accept that performance beyond 1080p likely won't be within reach.

Sticking to an ITX form factor will be tough, since ITX motherboards are usually more expensive than their mATX and ATX counterparts. We recommend sticking with AMD for your processor, allowing you to use an affordable B450 chipset motherboard.

When it comes to graphics, you have two options: Track down a cheap older GPU, or commit to gaming on integrated graphics. The former option is straightforward enough: AMD's RX 560 can still be found online for around \$150, with the superior RX 570 and Nvidia's GTX 1050 costing a little more. The latter is a bit more complex, since you may want to opt for an aftermarket cooler if you're planning on putting the full load of gaming on your CPU.

Integrated graphics are a lot more viable for

gaming than they were a few years ago, at least. The Ryzen 5 3400G only costs \$239 and can handle gaming at 1080p on medium to low graphics. No dedicated GPU saves space and effort as well as cash, and there's still the option to add a more powerful graphics card later on. Calculate your system's power draw and you may be able to choose a lower-power, cheaper PSU as well.

Keep an eye out for sales, and consider small adjustments that can be made for the sake of savings. Fractal Design's Prisma fans also come in cheaper, single-colour variants, so you can save some cash there. Lastly, we know HDDs can be attractive for low-cost storage, but don't drop any slower than SATA SSDs if you're using it for gaming.

*"Integrated graphics are a lot more viable for gaming than they were a few years ago, at least. The Ryzen 5 3400G only costs \$239 and can handle gaming at 1080p on medium to low graphics. No dedicated GPU saves space and effort as well as cash, and there's still the option to add a more powerful graphics card later on."*



### 03 TINY FANS

You need a tiny Phillips screwdriver for this step. The M.2 drive's heat sink has a tiny fan and two screw holes, one at each end. Unscrew this carefully, ideally using a screw bowl to keep the two tiny screws safe. A good mag-tip screwdriver will come in handy here. Once the screws are removed, lift up the heat sink, but be careful: It's connected to the mobo by a very short cable, so just lay it down right beside the port.

Check that you only have one standoff in place (it may come with others pre-installed, but these can be easily removed), then plug the drive into the M.2 port. Push it down gently until the groove at the opposite end lines up with the standoff, then secure it with one of the tiny silver M.2 screws included in the motherboard box. Once it's screwed down, remove the protective film from the sticky thermal pad on the underside of the heat sink and carefully mount the sink over the drive, before screwing it back into position.



### 04 COOL CUSTOMER

It's time to mount that air cooler. Remove the plastic AMD brackets either side of the CPU socket: Just unscrew them at both ends, and return the screws and the brackets to the motherboard box for safekeeping. Leave the metal backplate underneath the motherboard in place – you'll need it to mount the cooler.

The Wraith Stealth isn't difficult to mount, only requiring a screwdriver and a little thermal paste if it doesn't come with some pre-applied. If that is the case, just apply a pea-sized glob to the center of the CPU before proceeding. The Stealth should be positioned over the CPU so that its four screws line up with the backplate's screw holes, and the AMD logo on top points towards the rear I/O. Secure all four screws loosely first before tightening them one after the other, as the springs on each screw can require some pressure. Once the cooler is secure, run the power cable along the side of it and plug it into the "CPU\_FAN" header on the motherboard.







## 05 MEMORY TEST

If you're a regular reader of the magazine, we can probably just say "install the memory" here and be done with it. If not, you'll need to get the two separate sticks from your Corsair kit and release the clasps at the end of the DIMM slots, before lining them up and pushing them down into place until they click at both ends. This can be a daunting task for a rookie, as the silicon undersides of RAM modules are somewhat delicate, so offer a helping hand if you're getting a PC-building newbie to assemble this machine.

Be mindful of that cooler fan cable we just plugged in, too, as the header is very close to the DIMM slots, and it may get in the way. If you need to, just unplug the cable briefly then replace it once the memory is in place. MSI has packed a lot onto this little motherboard, but that has left it looking and feeling a little cluttered.

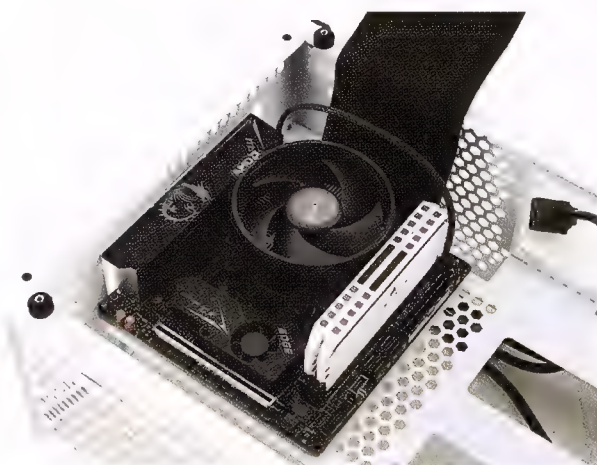
## Controlling chaos

Finding the right controller can be a complicated business, especially if you've built this PC for someone who is relatively new to gaming. A controller can be easy to get used to, so you may want to opt for something recognisable and familiar, like the classic Xbox One gamepad. This is a relatively affordable option too, costing around \$90. If you want to save money, you can find a budget controller – preferably one with good reviews.

Obviously, personal preference will come into play here. The divide between aligned joysticks and offset joysticks is a deep one, with many preferring Sony's gamepad layout over Microsoft's, or vice versa. Most good 3rd-party controllers follow the Xbox design, with the twin sticks laid out asymmetrically. If you want both sticks together, we'd recommend Razer's Raiju gamepad; otherwise, Razer offers the Serval and Wildcat pads for those who prefer an Xbox layout.

You can (and should) snap up a cheap keyboard and mouse for when you're navigating the desktop, although you can use AMD Link to launch most games from your phone, bypassing the need for a mouse. If the mouse and keyboard combo is your gaming preference, though, you should investigate the possibility of purchasing either a lightweight wireless keyboard or a lapboard.

Razer, Corsair, and more offer lapboards that are designed to work with both PC and consoles, so while you should be careful to check compatibility, there are plenty of options. Razer's Turret is a whole keyboard with a built-in extending mouse mat, while most lapboards are simply a wide panel with space for a keyboard and mouse. Lastly, you could opt for the "serious" choice: A compact keypad, like the Razer Tartarus Pro, which has a grid of keys and eight-directional thumbpad for one-handed control.



## 06 I/O ISSUES

If you try to mount this B550I motherboard immediately, you may run into problems. The pre-installed rear I/O shield is large and inflexible, so you might find (as we have) that it won't fit properly into the cavity at the rear of the case, making screwing the mobo down to the four standoffs virtually impossible.

To rectify this, remove the rear I/O plate. This can be unscrewed from the back of the motherboard, and doesn't make much difference besides protecting the interior from dust. This case might need dusting with compressed air more often, but the motherboard will fit perfectly without the shield. The board can then be screwed down on all four corners using the screws from the Ophion Evo's accessories bag. Don't forget to feed the flexible GPU riser beneath the motherboard before screwing it down, as it will need to be plugged into the PCIe slot on the other side of the board.



## 07 RAISE THE ROOF

Our two Prisma fans are going in the roof of this build, positioned towards the rear so that they draw air more effectively from the space around the motherboard, which will be generating more heat than the PSU going at the front of the case. This can be a bit fiddly, and may require an extra pair of hands if you don't have a mag-tip screwdriver handy.

Hold the first fan (facing downwards) up against the inside of the case ceiling, all the way at the back, then secure it to the roof with four of the supplied screws. This may scratch or distort the thin aluminum of the case, which is a sign that you've over-tightened the screws. Don't worry if the screws do warp the metal slightly: It will be hidden once you replace the dust filter later. Once you're happy with the positioning of the first fan, repeat the process with the second one. Leave the cables bundled for now; we'll deal with those later on.





## 08 POWER TRIP

Mounting the power supply in the Ophion Evo is a strange process. Place the case on its side (take care not to trap any loose cables) for access to the cutout on the underside where the PSU will be fitted. Make sure the extension kettle cable isn't in the way. Unscrew the rubber foot on the corner where the PSU will be mounted. Beneath this is a small hole through which you'll need to secure one of the screws for the PSU.

Place the power brick in the case with the fan facing outwards for better airflow. Secure it with four screws, then plug the extension cable into it, and feed any slack into the case. Don't worry if the cable rises over the lip of the cutout. With the PSU mounted, replace the foot, and plug in the three power cables: Motherboard ATX, CPU, and PCIe. Feed through and plug in the first two of these now; leave the PCIe cable loose in the front of the case.



## 09 PROCESSING GRAPHICS

If you haven't already, plug the PCIe riser into the motherboard before mounting it down. It should stretch comfortably and is flexible, although the lack of good instructions with the Ophion Evo is a frustrating. Once the riser is secure, move onto actually installing the GPU itself.

First, open the clasp on the PCIe slot mounted behind the motherboard, and remove the two blanking plates at the rear of the case. Put the plates aside or back in the case box, but keep those two screws – you'll need them to secure the GPU. Take the graphics card and line up the rear I/O with the metal slots at the rear of the case, then push it down so that it clicks into place in the PCIe slot. The clasp should snap into place once connected. Use the two screws to affix the GPU to the rear of the case, run the PCIe power cable from the PSU to the back of the case, and plug it in on top of the card.

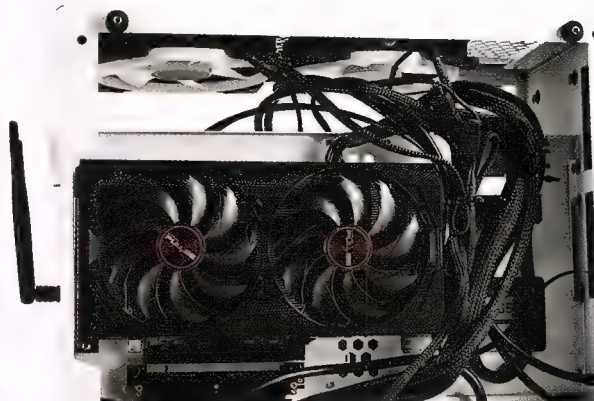
## Link to pilot

As anyone who already owns an AMD GPU will probably be aware, AMD's free Radeon Software received a major boost last year, both in terms of available features and a shiny new aesthetic upgrade that unified the visual style of AMD's various software options. The current Adrenalin 2020 edition is great, enabling you to tweak overclocking settings, update drivers, and optimise your system for individual games. It also packs a host of screen-capture and recording tools, with strong support for streamers. Nvidia's GeForce Experience looks a bit feeble in comparison.

One feature that really impressed us was the new AMD Link app, available for smartphones as well as some tablets and smart TVs. This tool has been around for a few years (it first launched in 2017) and was originally designed as a simple companion app for Radeon GPUs, allowing you to perform simple actions like taking a screenshot or monitoring system temperatures. Since then, though, AMD has introduced and refined a game-streaming feature that – in our humble opinion – puts competitors to shame.

AMD Link enables you to access any game on your PC (or simply your desktop) with a few taps in the app, loading fast and playing with very little latency over a remote connection. It's usable over 4G/5G mobile networks, but we wouldn't recommend playing anything high-intensity that way. Over Wi-Fi, though, it's awesome for squeezing in a few games on your lunch break.

Of course, AMD is still refining the software and adding new features. Voice commands have recently been introduced, allowing you to bark orders at your phone and receive system information. AMD has been adamant that new features will be determined largely by user feedback, so hopefully we'll see some more worthwhile additions in the future too.



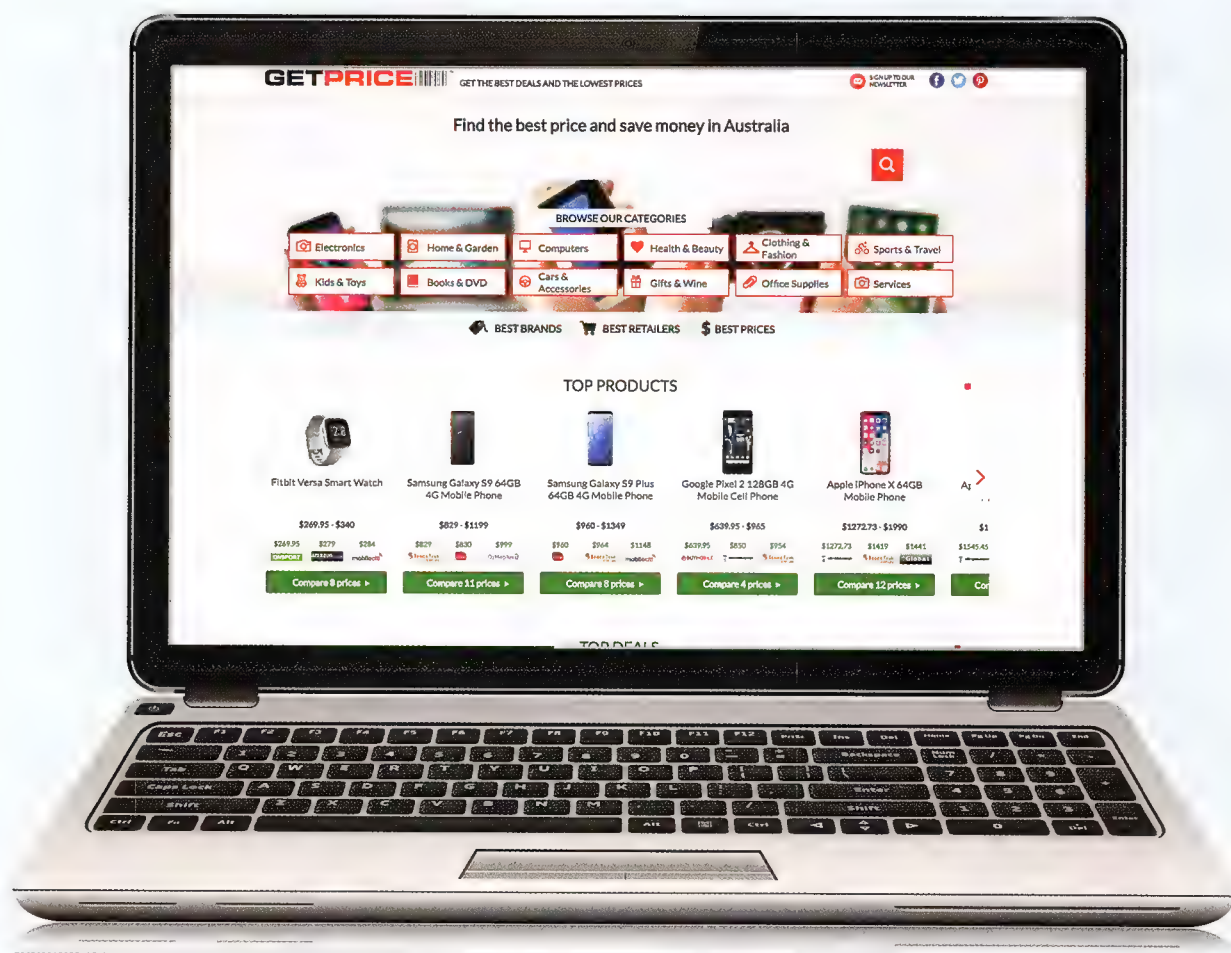
## 10 CLEANING UP

Let's wrap this build up. Feed the front I/O and fan cables through to the motherboard and plug them into the requisite headers, making sure to daisy-chain the male and female three-pin RGB cables from the Prisma fans so that you only need to use one header (that's the "J\_RAINBOW" header for instant lighting effects). Unfortunately, the Ophion Evo doesn't offer a huge amount of cable management, so use cable ties to bundle the various cables as neatly as possible and secure them to whatever you can inside the case's metal frame. Ensure that no cables run over the GPU or case fans; we've put them around the short end of the card and secured them as close to the front of the case as we can.

Once you're happy, replace the dust filters and side panels. Finally, take the two Wi-Fi antennas from the motherboard box and screw them into place on the rear I/O. Mission accomplished!



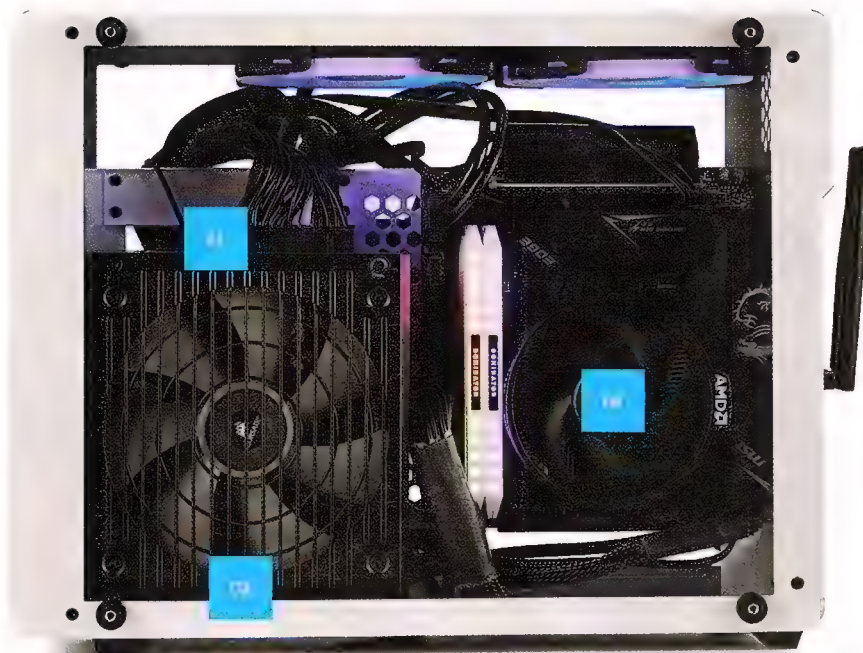




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**01**  
The PSU appears to take up a lot of space inside this case, but it's an intelligent solution that permits the use of a full-size ATX supply.

**02**  
Accessing the PSU power switch can be a bit of a pain when the case is upright, but it's hardly a major problem.

**03**  
The PCIe riser is wrapped in a durable fabric that allows it to be flexed and bent without being damaged.

**04**  
This cooler might be basic, but given the Ryzen 3 3100's low running temperatures, it works great.

## Small and somewhat mighty

This build proved slightly more complex to assemble than we'd hoped, but that may have come down to our ham-handedness while trying to plug in tiny I/O cables inside this cramped case. The finished product looks good and runs great, though, with satisfyingly low temperatures and noise across the board. In fact, our PSU and GPU fans spend a great deal of time not spinning at all, thanks to the low power draw and heat generation.

The processor doesn't blow us away in terms of performance, and our rather basic cooling solution means that throwing any CPU-heavy loads at this system isn't going to work well, but it handles games reasonably well without getting too hot. Post-testing, we installed Ryzen Master and activated its auto-overclocking functions, which eked around five percent of additional performance from the chip without any significant increase to running temperatures. A superior aftermarket cooler might help, but at that stage you'd be better off simply upgrading to a more expensive Ryzen CPU, such as the 3300X.

The RX 5500 XT we've used here

has 8GB of VRAM, a lot for a budget GPU. This will obviously benefit some games more than others, and CPU-bound titles likely won't fare as well on this machine, but shooters and platformers should perform well. Performance gains against the GTX 1060 are lower than we had hoped for, but 1080p performance was solid, and the additional features offered by the 5500 XT (such as the nifty Radeon Anti-Lag) make for a reasonable trade-off. Check out the "Link To Pilot" boxout for more on AMD's massively improved GPU software suite.

The rest of this build performs exactly as expected; the motherboard doesn't cause any bottlenecks, and the Samsung 970 Evo provides super-speedy load times in most games. While a PCIe 4.0 drive might have been superior, they're also more expensive, and the difference in transfer speeds isn't going to be noticeable to the average couch gamer. If a level loads in 1.4 seconds instead of 1.1 seconds, you shouldn't be throwing your gamepad through the TV in rage.

We're not quite sure if we'd build in the Raijintek Ophion Evo again. While it achieved an impressively compact frame without sacrificing on features, building inside it proved tricky on several occasions, and cable management was a struggle. Custom-length power cables may be a necessary purchase for anyone chasing that super-clean aesthetic. We're happy with our choice of power supply, though; the RM650x gives some room for future upgrades, although we would advise against trying to install a SATA drive in this case.

Still, front-panel USB-A and USB-C is welcome, and this machine looks great perched underneath a certain staff writer's HD flatscreen. We can't match the value of next-gen consoles, but we have our own advantages: Not having to pay over \$100 for games is a good start. Are we being petty now? Maybe, but we'll take the Steam Summer Sale over subscription-based online play any day of the week. ■

## APC LABS BENCHMARKS

|              | Cinebench R15 Multi | CrystalDisk 0032 Sequential | CrystalDisk 0032 Sequential | Rise of the Tomb Raider | Total War: Warhammer II | Tom Clancy's Ghost Recon: Wildlands | 3DMark: Fire Strike |
|--------------|---------------------|-----------------------------|-----------------------------|-------------------------|-------------------------|-------------------------------------|---------------------|
|              | Index               | Read MB/s                   | Write MB/s                  | fps                     | fps                     | Avg fps                             | Index               |
| Couch Potato | 1,010               | 3,575                       | 2,528                       | 77                      | 48                      | 30                                  | 11,997              |
| Zero-point   | 1,152               | 3,400                       | 1,720                       | 60                      | 46                      | 39                                  | 11,101              |

Our zero-point consists of an AMD Ryzen 5 1600, 16GB Crucial Ballistix Sport LT @ 2666MHz, an EVGA GeForce GTX 1060 3GB and a 250GB Samsung 960 Evo M.2 PCIe SSD. All tests performed at 1080p at the highest graphical profile.



## QUICK TIPS

# APC experts solve computing problems

The APC team tackle problems across the spectrum of devices and software. Learn a new trick or fix you can use.

## Broken Alienware?

*My monitor is an Alienware 25 and it says it will display 240Hz, but if I go to my settings to change it to 240Hz the screen goes black and then nothing happens until it reverts automatically to 60Hz. Do I need to have an Nvidia graphics card, or can I use it with an AMD graphics card?*

GREGORY MUENZER

**APC responds:** There are two versions of the Alienware 25 monitor, and which model you have will determine which card you'll need. The G-Sync version (model number AW2518H) requires a G-Sync compatible card, which basically means GeForce GTX 650 Ti Boost or higher. If you have an AMD card – any Radeon RX model – you'll need the FreeSync version (AW2518HF). One final consideration: 240Hz mode is only available through DisplayPort, it's not supported through HDMI, so make sure your card has a DP 1.2 or better.

If you have the G-Sync model with a compatible Nvidia graphics card, open Nvidia Control Panel and click "Set up G-SYNC" under "Display." Check "Enable G-SYNC" and click "Apply." Then, verify the AW2518H is the primary display under "Set up Multiple Displays," select "Manage 3D settings" under "3D Settings," and click the "Monitor Technology" dropdown to check G-SYNC is the selected feature.

Still struggling with G-Sync? Visit <http://bit.ly/MPCblurbusters> for a guide to setting up and optimising it.

## Move programs to new drive

*I want to know how to move my OS. I've upgraded from a 2TB Western Digital Black SATA HD to a 6TB WD Black drive.*

*I want to move Windows 10 Home x64 to an SSD all by itself and keep my program files on a separate 6TB drive with Windows pointing to the data drive. Is it*



*possible to do this and not have to reinstall all my programs?*

*I asked the tech support department for WD and Acronis (I used their drive clone software for my HD upgrade). Both tech support departments replied with responses that sounded like they were reading from a script, basically saying, "Yes, you can clone the old drive to the new drive very easily." I restated the original question and both companies skated around the question with the same reply. If it is possible to do this, what is the best-size SSD to use for Windows 10 Home x64?*

WILLIAM HECKEL

**APC responds:** It's technically possible to split off your programs and Windows without reinstalling everything, but APC isn't a fan of doing so – apps and Windows are tied together so tightly you might as well keep everything on the same partition. Now that 500GB SSD drives can be had for around \$90, you should find that it leaves you ample room for Windows and most apps.

What you can and should do is keep your personal files on a separate partition, so if something happens to your Windows partition they're still accessible. Step one of the process is to partition your current 6TB drive in

240Hz support requires G-Sync or FreeSync.

two, then transfer across all your photos, documents, files, and so on to the new partition. Do this by opening File Explorer to "This PC," right-clicking each of your user folders – Desktop, Documents, and so on – in turn and choosing "Properties > Location" tab to move it to your newly created partition. This ensures that Windows knows where the files have been moved to. Click "OK," the files will be moved (not copied) to free up space on your Windows partition.

After you've moved everything across, your Windows partition should be much smaller, but if it's still larger than your SSD drive, here's the bit you'll be most interested in: Moving apps and programs without reinstalling them. With apps installed through the Microsoft Store, navigate to "Start > Settings > Apps," click on an app, and use the "Move" button to switch the drive it's installed on.

Most programs can't be moved this way, which is where a free tool (Steam Mover, [www.traynier.com/software/steammover](http://www.traynier.com/software/steammover)) comes to the rescue. The app moves selected programs across to your data partition, then creates special shortcut links called "junction points" to fool Windows into thinking they're still on your C drive.

Steam Mover is incredibly easy to



use: Launch the program as an administrator and click “...” next to the “Steam Apps Common Folder” shortcut to select your Program Files folder, which is where most of your programs should reside. If you’re running a 64-bit version of Windows, programs are mostly split between here and the Program Files (x86) folders, so after moving programs from one folder, select the other and repeat the process.

Now click “...” next to “Alternative Folder” to choose a folder on your data partition. Finally, using the Size column to help identify the largest programs, Ctrl-click on the program(s) you wish to copy across. Once selected, click the blue right-facing arrow button at the bottom, and the files will be transferred. All actions can be undone later.

Focus on transferring as few programs as you can get away with – they’ll launch and run more slowly than those on your SSD, so place less frequently used programs on your data partition.

The final step of the process will be to clone your Windows partition to the new SSD using a suitable tool, making sure it copies the boot partitions as well as Windows itself. Once done, reboot, making sure your PC is configured to boot from the SSD – once back into Windows, which should boot more quickly now you’re on the faster SSD, you should be able to remove the original Windows partition from your 6TB drive and reallocate the space to your data partition or keep it separate (perhaps as a backup drive for your main Windows partition).

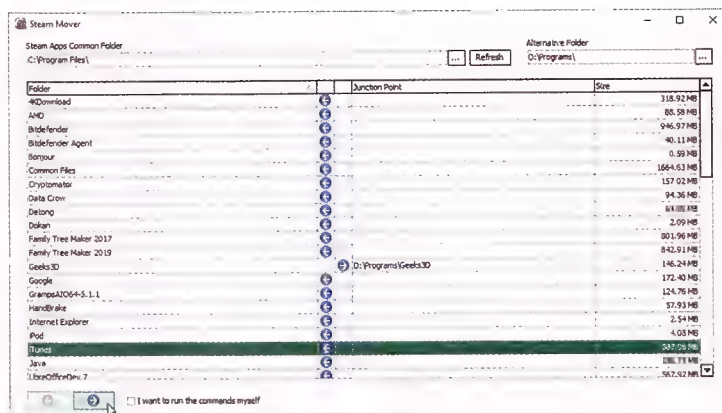
## Potentially tricky RAM upgrade

*I built my current system last summer around an MSI MEG Z390 ACE motherboard and a Noctua NH-D15S fan with only the original (inside) fan fitted. I currently have two G-skill Trident Z RGB 8GB DDR4-3200 sticks in the “proper” slots. Is it possible to add two more sticks without removing the Noctua tower first to do it? I know they will fit below the fan if I can get them in there. It seems like there’s enough room to slip it in below the fan, but I don’t want to have to remove that fan to do it. My system is performing fine now, but I’d like to do a bit more future-proofing.*

DOCDJ

**APC responds:** Judging from your motherboard manual, it appears

Steam Mover moves apps to another drive – no reinstall required.



you’ve got DIMMs in slots A2 and B2, which leaves the slot closest to the CPU as the trickiest to populate. That said, it looks like there should be enough clearance to get a new RAM stick fitted without too much trouble – although you’ll need to temporarily remove at least one stick of existing RAM (the one in slot A2) to give yourself room to fit the new RAM into slot A1 underneath the fan.

In fact, why wait to determine if you’ll be able to fit the upgrade without having to remove the fan? Power down your PC, and then open the case, having remembered to take the usual anti-static precautions. Remove the stick of RAM from slot A2, then try fitting it into slot A1 (if it’s a bit cramped, consider removing the stick of RAM from slot B2 too to give you more room). Once you’ve confirmed whether it’s possible, simply restore the RAM to the original slots, reboot, and you’ll know exactly what to expect when you upgrade your memory.

## File recovery

*I accidentally deleted three SMV files from a flash drive. I recovered the files using Recuva, but they’re corrupted. What can I do to recover such corrupted files? The videos are messages I made for my son, and I would like to keep the original files and not just make new ones.*

Thank you!

SCOTT SHERRILL

**APC responds:** The key to any data-recovery operation is to stop writing files to the affected drive as soon as you’re aware that data has been lost. As soon as part of the deleted files has been physically overwritten with fresh data, your chances of retrieving a non-corrupted file are pretty much zero. File recovery also works

better with more commonly used file types rather than niche formats like SMV.

All may not be lost, however: Because it’s an uncommon file type (along with the fact Recuva hasn’t been updated since 2016), you might find that another tool is better at retrieving it. Two tools to try are EaseUS Data Recovery Wizard (<http://bit.ly/MPCeasus>), which can recover up to 2TB of data for free, and DMDE Free Edition (<https://dmde.com>), which is a powerful tool supporting a wide range of file systems.

## Why drive letter X?

*What causes the HDD drive to change from C: to X: on booting?*

MANUEL TRUCCO

**APC responds:** The X: you’re seeing on booting into the Windows recovery environment isn’t your Windows partition, but a temporary RAM disk created by WinRE to load its own files into. That said, typing c: and hitting Return at this point wouldn’t necessarily have taken you to your Windows partition, so first type “diskpart” and hit Enter, then type “list volume” and hit Enter to see what letters the recovery environment had allocated to your drives. In rare cases drive letters may appear to be mixed up where there is more than one volume, but it’s all temporary – when rebooted, the Windows drive would have reverted to drive C. Ultimately none of this would have hindered any subsequent attempts to repair your system using the Lazesoft Recovery Disk.

APC recommends taking the time to set up a robust backup system using Macrium Reflect Free ([www.macrium.com/reflectfree](http://www.macrium.com/reflectfree)) to take regular system images of the entire drive to prevent any future disasters. ■



# Start (& Secure) your own WordPress Blog

Nick Peers wants you to share your content with the world.

One of the simplest ways to get yourself a website is through WordPress. This free and open-source platform is the world's most popular, and it's easy to see why. Although it started out as a blogging tool, it has since expanded to become capable of handling everything from personal websites to online shops.

We're going to start at the beginning by getting your site installed, set-up, secured, and ready for action. While the simplest way to set up WordPress is through signing up for a free account at [www.wordpress.com](http://www.wordpress.com), we're focusing on self-hosted solutions, whether through a third-party web-hosting platform like GoDaddy or Bluehost, or directly from your PC. The boxout opposite reveals what to look for in a web host, but if you already

have web-server capabilities via a server, you can use that too (or simply use your PC to host a locally stored site for personal use or to learn the ropes).

## Fuss-free installation

The latest version of WordPress can be installed on any server running minimum versions of PHP 7.3 plus one of MySQL 5.6 or MariaDB 10.1. Most web hosts should have these prerequisites in place – check its tools (such as Fantastico) for an option to install WordPress. If one doesn't exist, follow the instructions at <https://wordpress.org/support/article/how-to-install-wordpress/> to install it manually.

Synology users should install WordPress through their NAS's app store, but QNAP users should install it through Container

## YOU'LL NEED THIS WordPress server

Any reputable web host will do, or you can host it yourself on your own server. Logisim

Station for a more up-to-date version – search for WordPress, and then install the recommended App version, which essentially creates two linked containers (a database and then WordPress).

If you are planning on installing WordPress on an Ubuntu server, then you will need an Apache 2 web server (see <https://ubuntu.com/tutorials/install-and-configure-apache>). Once that is in place, follow the tutorial at <https://ubuntu.com/tutorials/install-and-configure-wordpress#1-overview> – it's designed for Ubuntu 16.04 or later, but it should work fine in other versions too.

Finally, if you want to install a local-only WordPress installation in Windows without making use of the Windows Subsystem for Linux (WSL), then visit <https://bit.ly/MPCaugwordpress> for a guide to setting up a simple web-based server using WAMP and WordPress.

## Initial steps

Administration of your new WordPress installation is done through your web browser. If you've set up your WordPress install through a web host, click the link to open it in a new tab; if you've set it up locally, you'll need to open your web browser and navigate to <http://192.168.x.y:12345>, substituting "192.168.x.y" with your server's IP address and "12345" with the required port number (such as 10084 for QNAP Container Station users).

You should find yourself presented with a screen asking you to select your language. The following page [Image A] will ask you to name your site, then create a master user for logging in and administering it. Avoid the use of "admin" here and protect it with a strong password (either use the one generated for you – store it in your password manager – or enter your own, with a minimum of 14 characters). Enter your email address to receive alerts, and decide if you want to discourage search engines from

Information needed

Please provide the following information. Don't worry: you can always change these settings later.

Site Title: nick's tutorials collection

Username: nick\_p

Password: n2CZlyK6Dpx3C'pog' (Strong)

Your Email: nick@mad.com

Search Engine Visibility: ☒ Discourage search engines from indexing this site

Configure Wordfence Firewall

If you cannot complete the setup process [click here for help](#)

To make your site as secure as possible, the Wordfence Web Application Firewall is designed to run via a PHP setting called `auto_prepend_file`, which ensures it runs before any potentially vulnerable code runs.

**NOTE:** If you have separate WordPress installations with Wordfence installed within a subdirectory of this site, it is recommended that you perform the Firewall installation procedure on those sites before this one.

We've preselected your server configuration based on our tests, but if you know your web server's configuration, please select it now. You can also choose "Manual Configuration" for alternate installation details.

Apache + mod\_php (recommended based on our tests)

Please download a backup of the following files before we make the necessary changes.

[DOWNLOAD HTACCESS](#)

Once you have downloaded the files, click Continue to complete the setup.

[CONTINUE](#)



making your site more visible to others. Finally, click "Install WordPress."

### Log in and browse

Once installed, you'll be invited to log in using the credentials you've just created. This will take you to the main WordPress Dashboard. This homepage presents information via a series of customisable widgets. On the left-hand side of the screen is the menu – roll your mouse over an item and a series of sub-menus appears. Click one, and the main view changes to that screen. Return to the Dashboard at any time by clicking its entry.

### Update your installation

WordPress sites have become increasingly susceptible to hacking, so let's add some essential layers of protection while you're here. Start by checking for any updates – they'll be clearly listed under "Updates" in the left-hand menu. Click this to review what's available: Core updates are at the top, followed by plugins and themes.

Start by installing any core updates, then check the "Select all" box next to plugins before clicking "Update Plugins." Once done, return to "WordPress Updates" via the link, and repeat the process for themes.

### Install a firewall

Keeping hackers at bay requires you to install several free plugins for your WordPress installation. Navigate to "Plugins" and click "Add New." Type "wordfence" into the search box and click "Install Now" next to "WordFence Security – Firewall & Malware Scan." Once installed, click "Activate." You'll see a new "WordFence" entry appear in the left-hand menu.

Go through the setup wizard, clicking "Continue" followed by "No Thanks" – the free version has all the functionality you need. Now click "WordFence" in the left-hand menu to view the plugin's own dashboard, providing a summary of the protection offered. A list of sub-menus appears on the left; under "Firewall" select "All Firewall Options" and click "Optimise the WordFence Firewall." Take a backup of your HTACCESS file, and click "Continue" [Image B] followed by "Close." Leave the firewall in

## Shared versus WordPress hosting

Many web-hosting providers offer a big range of hosting options, including dedicated WordPress packages. These often appear to be the logical choice for those looking for a fuss-free setup, but don't rush to commit: Take the time to compare these with the host's other packages (typically known as Shared, Linux, or Windows) and you may decide a more general package is better, largely because they support a range of applications – including WordPress but also options like Drupal and Joomla.

Key things to look for when comparing packages are: How many websites and/or subdomains do they support? Unlimited gives you the flexibility to add more WordPress sites or experiment with other packages. How much storage space is offered? Are there any bandwidth limits? How many databases does it support (most apps require at least one database)? Do you get a domain name included?

Higher-end packages also come with the promise of being backed up by more powerful hardware and free SSL certificates for additional security.

Look out for pricing – paying on a month-by-month basis is more expensive but more flexible. Many offer introductory discounts before the price jumps. Also check that added extras like SSL certificates and domains remain part of the package after the first year.

For a comparison of some of the best hosting packages offering WordPress packages, see [www.techradar.com/news/best-wordpress-hosting-providers](http://www.techradar.com/news/best-wordpress-hosting-providers).

learning mode for a week – it will then fully enable after this date.

WordFence also offers two-factor authentication via its "Login Security" menu to protect your WordPress account in case your login details are ever compromised. After enabling the feature, test it by logging out and back in, then return to "Login Security" and select the "Settings" tab, where you'll find an option to "Allow remembering device for 30 days." This means you can speed-up logins on browsers and devices you've logged into using 2FA by bypassing the prompt.

### Close the gaps

Go back to "Plugins > Add New" to install "All In One WP Security & Firewall," a 100 percent free plugin from Tips and Tricks HQ that contains loads of extra security tweaks to help ensure that your account remains secure. Once activated, the tool appears in the left-hand menu bar; click it to view its own dashboard, and be

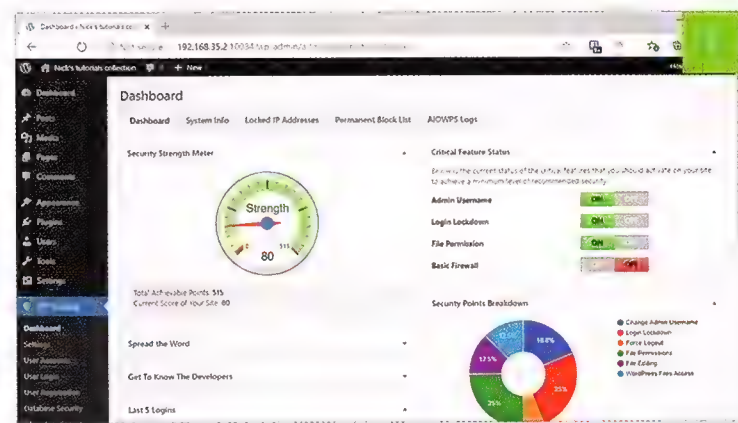
sure to enable the "Login Lockdown" and "File Permission" features under "Critical Feature Status" (leave the firewall disabled, as WordFence has that covered) [Image C].

### Force secure browsing

If your site is going to be publicly accessible from the web, you should ensure that all connections to it are made through the secure HTTPS protocol, to protect you against malicious scripts, as well as any information shared by visitors (or customers, should you set up an online shop).

You'll need an SSL certificate to secure the connection – unless you plan to make money from your site, you should be fine with a free Lets Encrypt certificate, which expires (and renews) every three months. Most hosting providers should offer this as a free option.

Once set up, install the "Really Simple SSL" plugin, which will automatically redirect all site requests so that they use the HTTPS protocol. ■







MAC

# Run Windows apps on Mac

Integrate Windows games and programs into your Mac desktop with Wine, with Nick Peers.

There are several ways to run Windows-only apps on your Mac, but only one allows you to run them directly from your Mac desktop, and that's Wine ([winehq.org](http://winehq.org)). Its command-line nature makes it fiddly to use, but thankfully more user-friendly variants exist.

Of these, CrossOver for Mac 19.0 ([bit.ly/cwwindowonmac](http://bit.ly/cwwindowonmac)) is by far the best way to get Windows apps working on your Mac, but it's not free: prices start from US\$20.95. Luckily, there are several free alternatives – they're not quite as user-friendly, but of these Porting Kit ([portingkit.com](http://portingkit.com)) still manages to take a lot of hassle out of the process.

One fly in the ointment is that you'll have to disable System Integrity Protection (SIP) to use it

in macOS Catalina. This requirement is likely to be removed from later versions, but if that makes you too uncomfortable, you might prefer to stick with CrossOver instead. Porting Kit makes use of another Mac-friendly solution – Wineskin – to convert Windows apps into self-contained application 'wrappers' that enable you to run them directly from the Applications folder as if they were native programs.

## Get started

First, disable SIP: reboot your Mac into macOS Recovery (press Command-R at startup) and then choose Utilities > Terminal. Type 'csrutil disable' and press Return, then reboot.

Next, download Porting Kit.zip from [portingkit.com/download](http://portingkit.com/download)

## IT WILL TAKE

25 minutes

## YOU WILL LEARN

How to run 32-bit Windows apps on your Mac in Catalina

## YOU'LL NEED

Porting Kit (macOS 10.8 or later), SIP disabled (Catalina only)

to your Downloads folder, then double-click it to extract the application, which you then move to the Applications folder.

Launch the app and click OK when the system warning pops up. Launch it again and click OK when the secondary warning pops up – it should now open. You'll be prompted to create a Games subfolder inside your user Applications folder – click Yes to do so. After a couple of prompts, click Open System Preferences to tick Porting Kit under Input Monitoring – click Quit Now before restarting the app.

Before going further, a word of warning: many antivirus applications incorrectly flag files created by Wine as threats, either quarantining them or deleting them entirely. It's a good idea to disable real-time protection while installing any apps in Porting Kit.

Once done, add your newly created app to your antivirus list of exceptions and it should avoid falling foul of its real-time protection going forward.

Back in Porting Kit, click the Library button. Use the slider/page

*"One fly in the ointment is that you'll have to disable System Integrity Protection (SIP) to use it in macOS Catalina. This requirement is likely to be removed from later versions, but if that makes you too uncomfortable, you might prefer to stick with CrossOver instead."*



## EXPLAINED... The Porting Kit interface

### VIEW INSTALLED APPLICATIONS

Click an app to read a description or launch it. Click 'Add application' to add other Wineskin apps to the list.

CONFIGURE YOUR WRAPPER  
control-click an app to access various options for configuring and tweaking it.



### GET HELP

Click Community to access an online help forum dedicated to Porting Kit or to contact the developers.

### RATINGS

Other Porting Kit users rate the game's performance based on its graphics – click Rate Here to add yours.

numbers to browse a massive library of supported games or search for a favourite game. Select one for a description – note some games may require purchasing. Keep an eye out for games marked with 'Free' such as *2 Fast Driver*.

When you've found one you like, click Install followed by Install Now to open an installation wizard, which steps you through the install process. Once done, the game will appear in the left-hand menu as well as in your user's Applications > Games folder. Just run it like any other app.

### Install an app manually

Porting Kit's huge library is exclusively a gaming one, but it can be used to set up and run Windows apps too. First, check the app's compatibility on [appdb.winehq.org](http://appdb.winehq.org) – make a note of which version runs best, and any additional requirements such as the .NET Framework, which you'll need to install separately. After downloading the program installer from its website, open Porting Kit and choose Tools > 'Find out EXE needed libraries', then select your program installer to view a list of required libraries. Most should be provided as standard in Wine but make a note of them in case you

**GENIUS TIP!**  
Create your own blank wrappers using WineskinServer ([portingkit.com/newwineskin](http://portingkit.com/newwineskin)), then click Add Application to add them to Porting Kit.

**JARGON BUSTER**  
Porting Kit (and Wineskin) use the term wrapper for the self-contained application bundle created when you set up a Windows app.

run into any problems.

The step-by-step guide reveals how to manually install an application that has no additional demands: MP3tag. But it's likely your chosen app requires a bit more effort to get it working. Start by following the guide to see how far you get.

### Further configuration

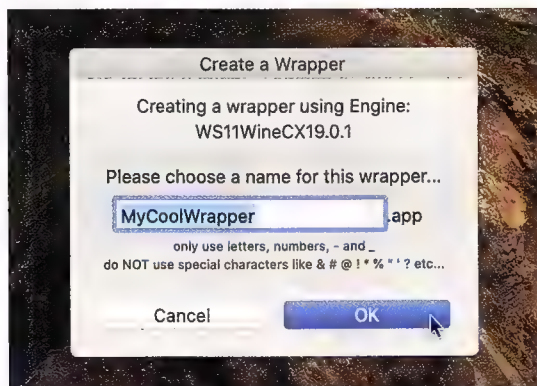
If you're prompted to install any additional components, try to complete the installation first. Once done, Control-click the new shortcut in the left-hand pane and choose Wineskin Tools > Launch Wineskin. Click the Advanced button, switch to the Tools tab and click Winetricks under Utilities.

Winetricks should make it easier

to install common Windows components into your wrapper to give your program the best chance of working. After a pause, you'll see a list of categories appear – instead of browsing these, use the search box to find missing components (such as 'dotnet' to view .NET Framework packages). Place a tick next to the component or components you need, then click Run. Follow the install progress in the bottom pane and – if all works as it should, you should see when it's installed. Try running or installing your app again.

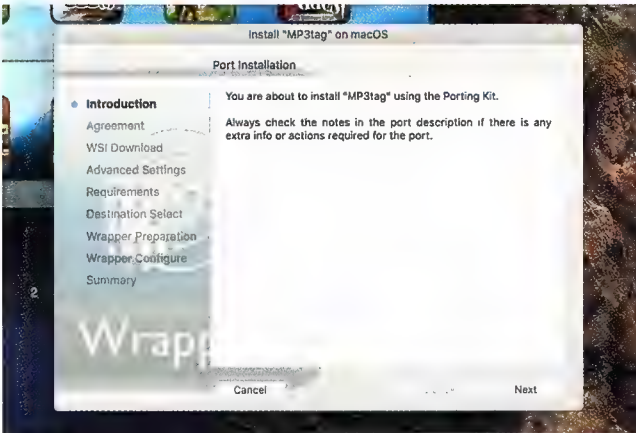
The Wineskin Advanced menu has other uses too: under Configuration you can set which program launches when the wrapper starts or click Test Run to verify things are working as they should be. The main Wineskin Tools menu offers other handy shortcuts too – select Wine Configuration to change the Windows version of your wrapper, tweak graphics settings, link folders inside the wrapper to those on your Mac, and more.

Remember, running Windows apps on your Mac remains distinctly hit and miss. Many apps will run – some perfectly, some with glitches both large and small – but many others won't. There's no hard and fast rule, so be prepared to experiment and good luck!

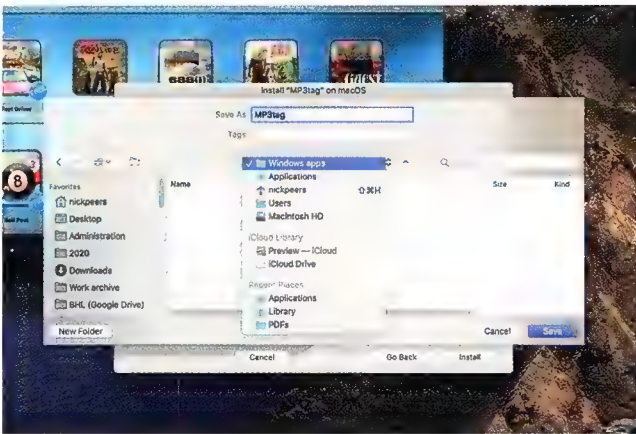




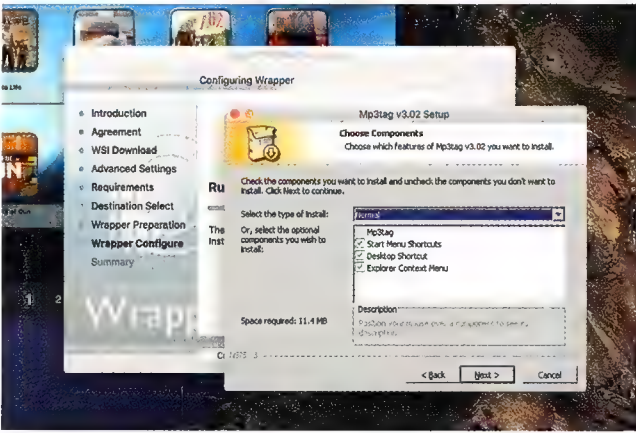
# HOW TO Install a non-listed app



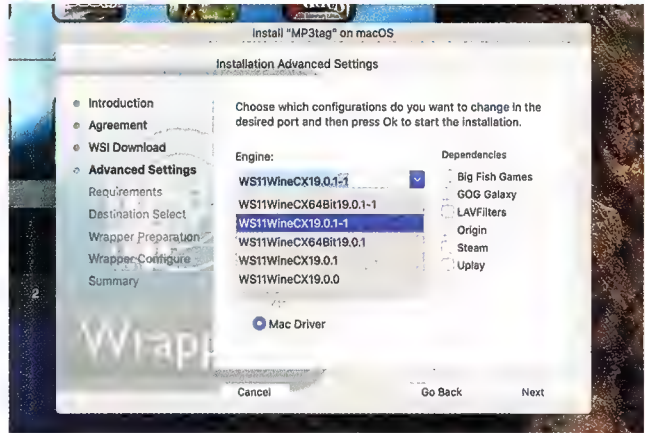
**01 FIRST STEPS** After downloading the program installer from its website, open Porting Kit and choose File > New Custom Port. Type in the name of the application you're installing to easily identify it. Click OK. An installer wizard will open.



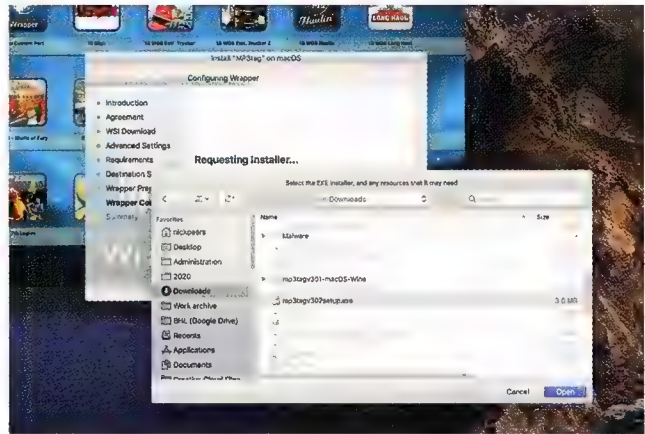
**03 CHOOSE DESTINATION** Click Next again to select destination – Applications > Games folder by default, so click Change Install Location to change it to Applications or to create a new subfolder inside Applications for Windows apps. Click Save.



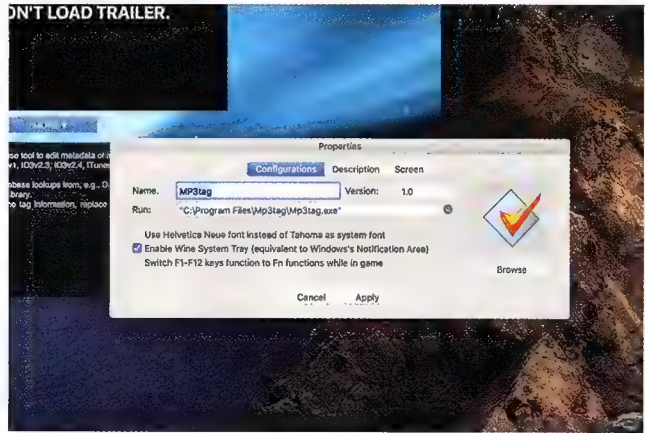
**05 COMPLETE INSTALLATION** The program's own installer will pop up – follow this through to its end. Leave the default settings as they are. After installation you'll be prompted to locate the program file. Once done, click Close to finish.



**02 SET WINE VERSION** Click Next, skim the license agreement and click I Agree. You'll be prompted to select an engine – choose the latest 32-bit version (WS11WineCX19.0.1-1 or later). Leave the dependencies unticked and click Next.



**04 SELECT APP INSTALLER** Click Install and wait while the app wrapper is created along with some required dependencies. When prompted, browse to the folder containing your downloaded program installer, select it and click Open.



**06 TEST AND CUSTOMISE** Your app will appear in the left-hand pane of the main Porting Kit window as well as in Applications. You can Control-click its entry in Porting Kit and choose Properties to add your own icon and description.



# How to apply thermal paste

Zak Storey knows the right way.

Everything in computing is polarised. Nvidia or AMD? Apple or Windows? PC gaming or console? There's a whole plethora of argument-inducing debates to be had and statements and brands to align yourself with. And that is very frustrating, because a lot of the time it genuinely gets in the way of real progress and learning. Nowhere is this more evident in computing than with the "debate" surrounding the application of thermal paste.

When you take a step back and think about it, it sounds insane. How can arguments descend out of this madness? Surely the way someone applies thermal paste isn't worth having a fight over? This journalist has to admit he didn't always think like that. There was one way of applying thermal paste, and that was it. It was only after being challenged by our resident modder and peripheral guru, Dave Alcock, that he finally did a bit of testing, and changed his ways.

Simply put, how you apply thermal paste has no noticeable effect on temperatures at all, as long as there's enough paste between your CPU's integrated heat spreader and the CPU block attached to your choice of cooler. That's it. It doesn't matter. You can empty an entire tube of the stuff onto a processor if you like, the reality is there's no noticeable temperature difference outside of margin of error at all between a carefully applied layer and a tube of the stuff thrown on top. But that said, if you want to save some cash and maximise your thermal paste (saving some for later, and reapplications), or alternatively you're looking at applying a liquid-cooling block to a GPU, where do you begin?

## The right paste

Perhaps more important than anything else when it comes to thermal paste is that you choose a paste that's easy to spread and non-conductive. You don't want a runny paste that spills out everywhere, and nor do you want one that has some form of conductive capacity to it.

If you accidentally spill some of that on the side or onto the



processor's PCB, you're looking at a short circuit, a quick trip to RMA land, and one expensive bill in the process. That's not to say there isn't a place for this stuff (it's great on older processors that you can delid carefully), just that for everyday use, you're better off with the non-conductive stuff.

We always use Noctua NT-H1 at APC [Image A], not because we have some advertising deal with them, but purely because its consistency is thick, meaning you can apply it pretty much upside down if you wanted and it'll sit in place, perfectly fine. It also takes an eternity to dry out, and provides strong performance, with zero conductivity too – all trademarks of a good paste. The H2 stuff, although just as good a performer, is a bit worse in our eyes, because it's more liquid than solid, and not as confidence-inducing as the H1 line.

## Threadripper and beyond

With any mainstream Ryzen processor or Intel LGA 1200 chip and below, you can get away with just taking a tube of paste and applying anywhere between a pea-sized dot (or a grain of rice, or whatever your desired size metaphor is) and a small pebble in the middle of your processor and be absolutely fine, as long as it's non-conductive.

That said, there are processors around on which this won't work as

**YOU'LL NEED**  
Non conductive  
thermal paste.  
Recommended:  
Noctua NT-H1.

effectively – Threadripper being one of them. In this instance, we typically apply two thick lines, inwards down the longest sides of the chip, with a bigger dot in the middle. By design, the core complexes on Threadripper sit in a cluster of four, one in each quarter, so making sure you have ample coverage here is important. The same goes for Intel's high-end Xeon parts – ensuring you've got plenty of thermal paste coverage here is paramount to solid thermal performance under load.

## GPUs and waterblocks

When it comes to graphics cards, you'll often see manufacturers such as EKWB, Phanteks, or Alphacool recommend that you create a star pattern of thermal paste on the GPU itself, with their included paste. You really don't need to do this at all. The GPUs themselves are still relatively small compared to the likes of the high-end desktop chips, and as such you can get away with approaching it in a similar manner to Ryzen processors and LGA1200 and below parts. A big dollop in the middle and you're good to go.

If you're still not quite convinced that thermal paste application doesn't matter, you can check out this video here from our friends over at Gamers Nexus, where they go into far more detail regarding testing the whole procedure: <http://bit.ly/TPasteNexus>. ■







iOS

## Sort out your social life

Say ciao to annoying calendar clashes with the Howbout app.

Screen Time is designed to show you how you use your phone and help cut down your usage. It is not perfect, though. Sure, you can limit how much time you spend on your device, but you only get a couple of choices over how to do that. Your usage data is more or less restricted to the number of pickups and notifications you had.

It is fine, but not outstanding.

OffScreen offers features that Screen Time lacks, from multiple focus modes to detailed stats on how you use your device. It also incorporates tools that Apple has scattered about iOS (like bedtime reminders) in one place, making it much easier to manage your time on – and off – your iPhone.

### IT WILL TAKE

10-15 minutes

### YOU WILL LEARN

How to understand and curb excessive iPhone usage

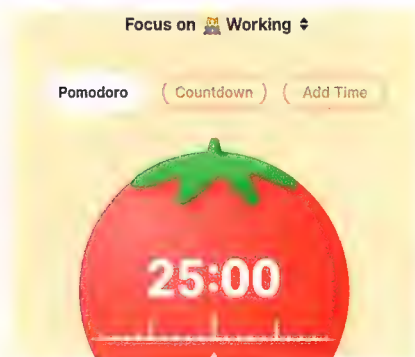
### YOU'LL NEED

iOS 11 or later, OffScreen

A lot of OffScreen's features require an upgrade to Pro mode, which unlocks all data categories, a range of customisation options, and a wealth of other options (see 'Other useful features'). This is a one-off upgrade for \$2.99, and considering the amount it unlocks, we think it is worth it.

ALEX BLAKE

### HOW TO: Use OffScreen's Focus mode



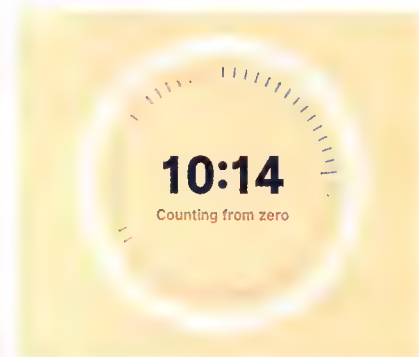
#### 01 POMODORO TIMER

On the Focus screen, tap Pomodoro. Tap Default next to 'Focus on' and pick a category. To change the length of your session, slide the bar on the tomato icon; you can choose between 10 and 120 minutes. Now tap Start to Focus.



#### 02 COUNTDOWN TO SUCCESS

Tap Countdown on the Focus screen. Like Pomodoro, you can choose a category for your session. While Pomodoro is designed for short study periods, Countdown mode lets you stay focused for up to 24 hours at a time.



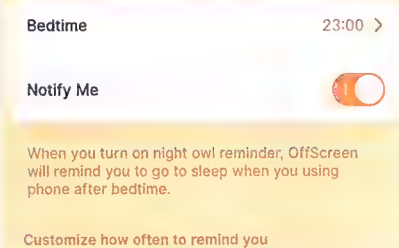
#### 03 ADD TIME

The final option is Add Time, which works like a stopwatch that tracks how long you stay on target. Choose a category, then tap Start to Focus. When you are finished, tap the pause or end buttons in the top-left or top-right.



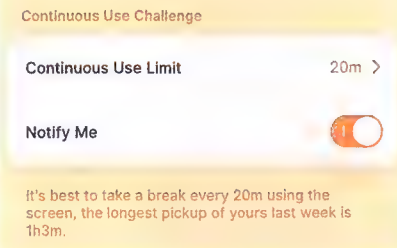
## HOW TO: Adjust key settings

### Night Owl Reminder

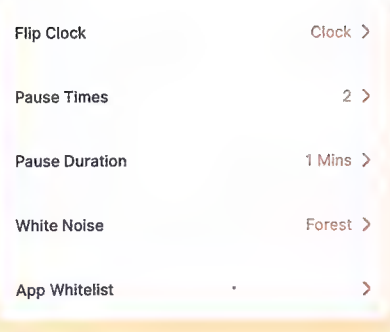


**01 SAY GOODNIGHT** Tap the settings gear icon, then tap Night Owl Reminder. Tap Bedtime to choose when you go to bed. OffScreen will remind you to put your phone down at this time. You can choose how often and how aggressively it reminds you.

### Continuous Use Challenge

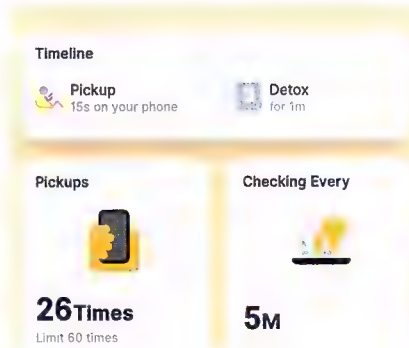


**02 KNOW YOUR LIMITS** Use the Challenge settings to adjust how assertive OffScreen is in reminding you to have a break. For example, tap Continuous Use Challenge, then raise or lower the limit to set when the app suggests you take a breather.

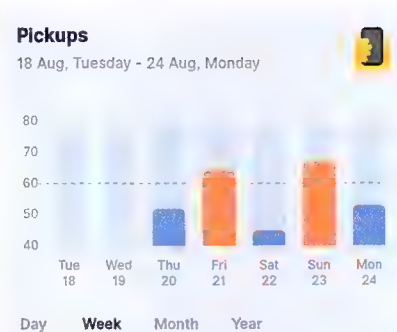


**03 IN SHARP FOCUS** Focus mode can be adjusted in settings too. You can alter the number and duration of pauses you are allowed, the style of white noise the app plays, which apps are allowed through the Focus firewall, and more.

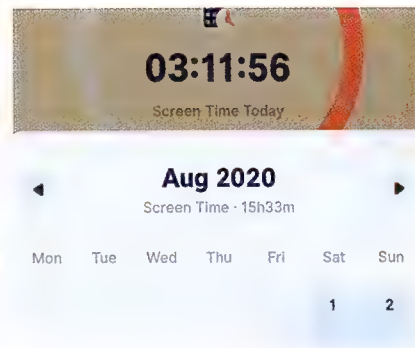
## HOW TO: Gain insights into your usage



**01 CATEGORISED DATA** OffScreen's main screen shows your iPhone usage broken down into a range of categories. At the top is a timer showing how long you have used your phone today. Each section has a card, which you can tap to get more detail.



**02 DRILL DOWN** Tap Pickups. You will see a weekly overview of how many times you unlocked your phone each day. Tap Day to get an hour-by-hour breakdown for each day. Underneath is a summary of average pickups, highlights, and more.



**03 VIEW HISTORIC DATA** Tap the calendar icon in the top-right, then select a date. You can browse statistics from this day as you do for today's data, with everything sorted into categories. Tap Back to Today to return to the present.



## Other useful features

### More tools to keep you on track

OffScreen Pro comes with a host of useful extras, besides the ones we have covered so far. It lets you back up your data to iCloud, and you can sync your sleep and focus times with Apple's Health app. We also like that you can create unlimited custom tags for your focus sessions. But you do not need to pay to get useful bonus features. The free version of OffScreen gives you daily and weekly reports, for example, which summarise all your key stats into an easy-to-digest card. You can save these cards for future reference or share them. ■

*"The free version of OffScreen gives you daily and weekly reports, for example, which summarise all your key stats into an easy-to-digest card."*



# Best open source tools

Nick Peers reveals 10 fantastic tools and applications that should be on every Ubuntu user's radar, for maximising their time in the distro.

An operating system stands or falls on the quality of its programs, and Linux is no exception. Thankfully, you'll find a rich seam of applications spanning all your needs, and we've dug out 10 of the absolute best to help you get started.

Unless stated, all programs can be installed through the Ubuntu Software store app, but where multiple versions exist, choose the Snap version, which will ensure you'll always have access to the latest version.



## VLC Media Player

Ubuntu's built-in Videos tool is good, but it will struggle with more demanding movies – for example, it can struggle with 4K video encoded using the h.265 codec. That's where VLC Media Player ([www.videolan.org/vlc](http://www.videolan.org/vlc)) steps in. This configurable video player can handle just about anything you throw at it, making it a reliable choice for anything you care to watch through your PC.

VLC can even do a great job of playing HDR content through non-HDR displays without making the image appear dull and washed out, but you'll need to set things up first. Choose Tools > Preferences > Video tab. Select All under Show settings to reveal all available options, then expand Video > Output modules to select OpenGL. Change the Tone-mapping algorithm dropdown to Mobious (linear + knee) and click Save to produce more vibrant images.

## Converseen

Ever had to resize or convert multiple images one at a time? The repetitive actions of load, resize, save aren't simply time-consuming, but can easily result in mistakes or inconsistencies. Converseen ([www.converseen.fasterland.net](http://www.converseen.fasterland.net)) ensures your group of images can be resized, converted, flipped, rotated and even renamed with just a few clicks.

Click Add Images to select one or more images. Once they've appeared in the list, use the Actions Panel on the left to resize (by a specific number of pixels or scale factor of one to 100 per cent), flip, and/or rotate. You can also choose a different directory to save your converted photos in, and rename them by adding a prefix, suffix, or progressive number. Once done, pick your output format, then click Convert.



## Krita

Painting on a digital canvas has come of age in recent years, and Krita ([www.krita.org/en](http://www.krita.org/en)) is a free, open-source tool that produces stunning results. That's in part because it's been developed by artists, reflected by its smart, intuitive user interface that boasts over 30 different panels – or 'dockers' that you can move and customise as you see fit.

While you can draw using your mouse, Krita works best with dedicated pressure-sensitive drawing tablets, that make it easier to draw with strokes of varying sizes – just make sure you pick a model with Linux drivers (visit [<https://store.huion.com/products/hiuion-hs64>\) for details\). If you're happy with a smaller drawing canvas, then the HUION HS64 tablet \(<https://store.huion.com/products/hiuion-hs64>\) is a good entry level choice – it'll work with your Android device as well as your PC. It's available through Amazon for \\$60.99.](https://</a></p>
</div>
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## digikam

Just how many digital photos have you taken over the years? We bet it's in the thousands, and while Shotwell does an okay job of helping you organise them, if you want to take things to another level, you need digiKam ([www.digikam.org](http://www.digikam.org)). You'll find options for advanced users: RAW format support, a wide range of metadata-adding tools (including the ability to tag faces in photos) and even a built-in image editor that's more accessible than GIMP, but still packed with useful tools and filters.

One tip: after installing, click Permissions to grant the program access to your digital camera, so you can transfer files directly off it instead of having to remove the memory card to transfer via a suitable card reader.



## Bitwarden

Everyone needs a secure password manager – a tool to generate and remember strong, random passwords, leaving you the burden of only remembering one master password to unlock them all. And when it comes to password management tools, there's no better than Bitwarden ([www.bitwarden.com](http://www.bitwarden.com)). It's open source so completely transparent, and runs on all major platforms, including your favourite web browsers.

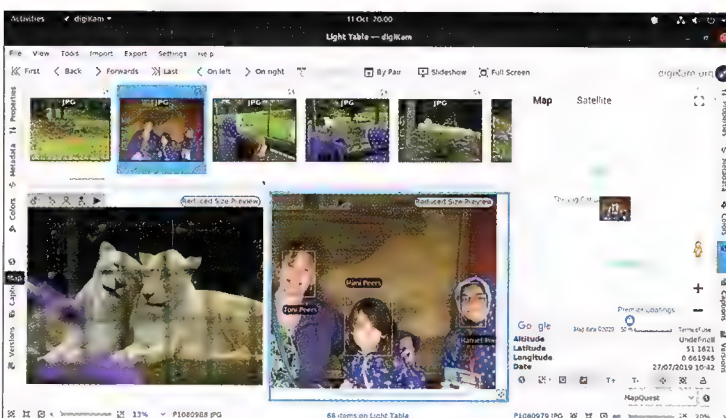
Another plus point for Bitwarden is that you can run your own lightweight password server to keep your passwords stored locally instead of in the cloud.



## CopyQ

The clipboard is one of computing's great time-saving tools, but it's hamstrung in that it only remembers the last item you copied. CopyQ solves this problem – when it's running, it'll store every single item you add to

digikam takes professional-level photo management to the next level – the Light Box is just one of its many powerful tools.





the clipboard, enabling you to paste these clips simply by selecting the relevant item from the CopyQ menu (click its icon in the top bar to access it), or by assigning your own custom keyboard shortcut for even faster access.

Other features include the ability to manage clipboard items – you can edit or remove existing clipboard items, add your own from scratch, assign tags to make them more easily identifiable through searches, and organise clips into customisable tabs.

We recommend installing CopyQ through its own repo so it can update itself automatically – add `ppa:hluk/copyq` to the list of repos under Software & Updates>Other Software tab and then install it via `sudo apt install copyq` in the Terminal or via the Synaptic Package Manager (see above right).

## Caffeine

When your desktop is sat idle for a certain period, your monitor will blank and Ubuntu will trigger the screen lock. That's fine if you've stepped away from your desk, but what if the monitor goes blank during your attempts to read a long story without meaningful mouse activity?

You could – of course – change your lock-screen settings via `Settings>Privacy>Screen Lock`, but that won't stop the screen blanking. You could try to remember to press a key or move the mouse every few minutes. Or you could install Caffeine from the Software Centre – launch 'Caffeine indicator' from the App launcher and you'll see a tiny coffee cup icon appear in the top menu bar. Click this and select Activate, and the desktop won't be able to time out whenever you run an application full-screen. Problem solved.



## OpenShot

These days, shooting video is easier than ever, and when it comes to bringing it all together, OpenShot is our go-to video editor. It's user-friendly – import your video, audio, and photo files into the Project Files window, then drag them into position on the multi-track timeline. Use the tool's non-destructive trimming tools to tidy up your clips, then turn them into a professional-looking movie with the help of special effects, transitions between scenes, and titling and captions.

Be sure to download OpenShot as an AppImage from [www.openshot.org](http://www.openshot.org).

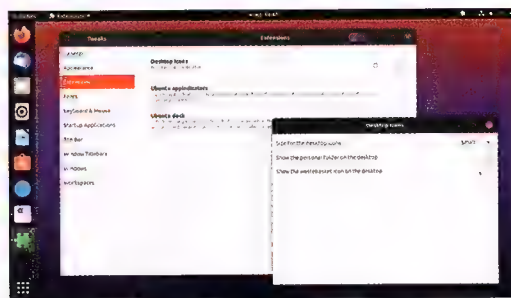
Fed up with using 'apt' in the Terminal to install packages? Synaptic Package Manager provides a graphical frontend that's easy to navigate

## Configuring the GNOME desktop

Ubuntu ships with the Gnome desktop, but when you explore the Settings tool for options to configure things you don't like about it you're likely to be left disappointed by what you find.

The solution is GNOME Tweaks (<https://wiki.gnome.org/Apps/Tweaks>). Once installed through the Software Centre, search for Tweaks in the App Launcher to open it. You'll be greeted by a two-pane window, with categories on the left, and available tweaks on the right. These consists of simple on/off sliders, drop-down menus, and the occasional numerical value. Most are self-explanatory, but to remove those desktop icons requires clicking the Settings button next to Desktop icons under Extensions, where you'll find the relevant options.

If you want to dig even deeper into Gnome – and are willing to take more risks with your system – then install `dconf-editor` through the Software Centre alongside Tweaks. Its tweaks aren't as easy to fathom, but it goes a lot deeper and enables you to tweak Gnome tools like Rhythmbox and the Cheese webcam software. If you run into problems, right-click a setting or parent folder and choose Reset recursively to undo them.



GNOME Tweaks gives you more desktop configuration tools than you'll find under Settings.

**org** and run it on a powerful multi-core processor with SSD drive and 8GB or more of RAM to produce jitter-free playback.

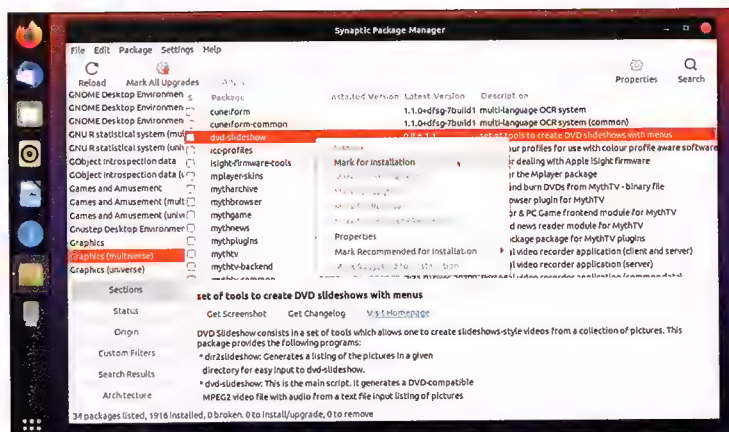
## Synaptic Package Manager

Synaptic Package Manager is a graphical front-end for the apt tool, which is used to install, upgrade, remove and generally manage all installed packages on your PC. Unlike the Ubuntu Software tool, which provides access to only certain packages, anything that can be installed through apt can be installed through SPM, which is the default package manager for other Linux distros.

Perhaps unsurprisingly, you can't install this 'rival' product through Ubuntu Software (fake news! you can – Ed); instead, open the Terminal and type:

```
$ sudo apt update && sudo apt install synaptic
```

Once installed, launch the program through the App launcher and you'll see the main app window listing all available packages. Packages already on your system are marked with a green checkbox, and clicking the checkbox next to an item reveals available options for marking it for installation or process immediately. ■





# Build the ultimate audiobook collection

Nick Peers reveals how to put together your own audiobook library using CDs, free downloads and Audible purchases.

We all love a good story – after all, telling stories around the fire is as old as human language itself. Audiobooks – and radio dramatisations – continue that tradition into the modern age, and thanks to your phone and PC, give you the opportunity to listen to your favourite books wherever you are.

In this guide, we'll show you how to bring all your audiobooks – whether on CD or in the cloud – into one central library. You'll add tags to make them easy to identify, plus discover how to listen to them from your PC or phone. Let's get storytelling...

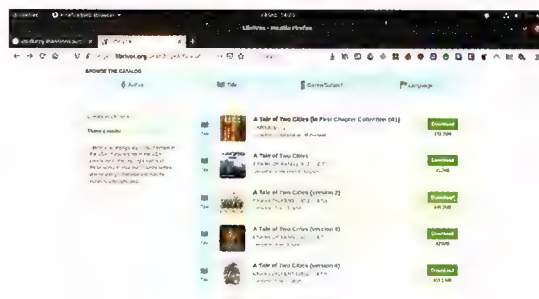
## Set up your Audiobook library

There are three principal places to source audiobooks: on CD, with unabridged editions spanning dozens of discs; from an online

vendor (the obvious example being Audible); and finally, from free websites where classic books – namely, those now out of copyright – have been narrated by volunteers can be found.

One of the best sources of free audiobooks is LibriVox ([www.librivox.org](http://www.librivox.org)). When you find a title you like, choose the 'Whole book (zip file)' option to download the book as a series of MP3 files, one per chapter. Each file is tagged with author, title and other key details, and you can also download cover art from here to illustrate the book in your library – more on tagging and artwork later.

Where will you store your audiobooks? The simplest option is to create a dedicated folder – Audiobooks – which can reside inside your Home folder. Books can then be stored within the



Listen to one voice reading the text in LibriVox in the Solo audiobook versions.

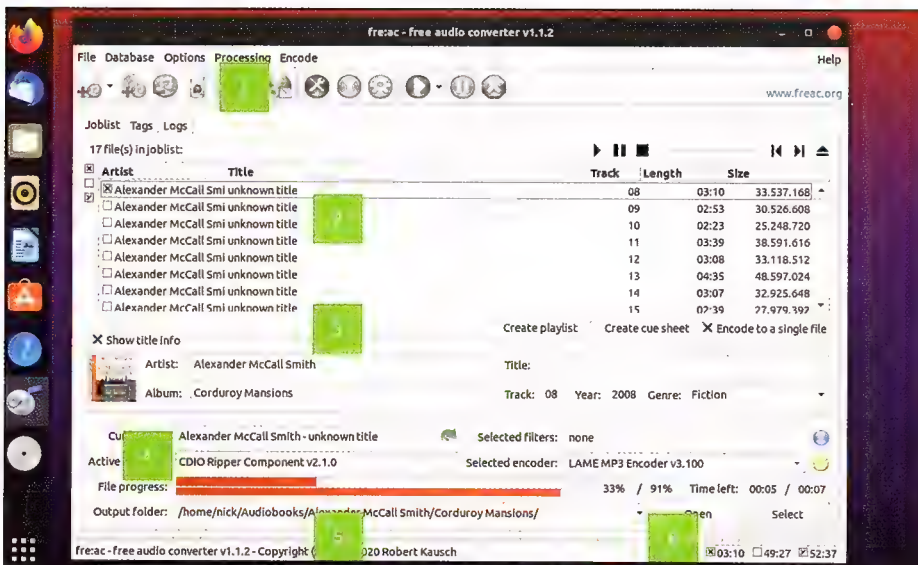
following folder structure: Audiobooks\Author\Title – for example, Audiobooks\Herman Melville\Moby Dick. If your collection threatens to get out of hand, or you'd like to subdivide your library (say separating children's titles from your wife's collection of thrillers), add another layer – Genre – between Audiobooks and Author.

## Audiobook file breakdown

Another important consideration is how you intend to store individual audiobooks. Audible supplies entire books as a single file, and whatever chapter markers are embedded in its native file format (AAX) will be lost on conversion. Conversely, audiobook CDs split each CD into short tracks – three- to five-minutes long – to aid navigation through CD players.

Neither option is particularly desirable. Your audiobook player should be able to pick up from where you left off, but it's still handy to be able to jump to a specific chapter or section of a book quickly. The approach adopted by LibriVox books is best – one file per chapter, and this is something that OpenAudible can do with your Audible library by splitting books into separate files – one for each chapter – during the AAX-to-MP3 conversion process.

It's more complicated with CDs where you need to combine multiple tracks into a single file, and choose where to break them: by CD, so each file spans 60-70 minutes; chapter – can be fiddly to locate where each chapter begins, and not always an option with abridged audiobooks, or arbitrary break – say splitting each CD into two 35-minute or three 25-minute 'parts'. Thankfully, our ripping



## Rip audiobooks with fre:ac

### 01 FRE:AC CONTROLS

The buttons provide shortcuts to frequently accessed tools and settings, including the all-important rip button.

### 02 JOBLIST

All tracks requiring processing are listed here. Use the controls on the left to quickly select all, deselect all or invert selection.

### 03 METADATA

Although fre:ac enables you to edit the currently selected track's metadata, it's quicker and easier to use Kid3.

### 04 MONITOR PROGRESS

Progress bars show you how far the ripping process has got – both for the current track and the overall selection.

### 05 OUTPUT FOLDER

You'll need to set this manually for each audiobook CD you rip owing to issues with fre:ac's automated tools.

### 06 MONITOR TRACK LENGTH

When dividing audiobooks into roughly equal 'parts', the figure next to 'X' helpfully reveals the combined length of your selection.



tool of choice – fre:ac – can handle any of these options with aplomb.

Convert your Audible library

Let's start with revealing what do with your Audible collection. You're probably already listening to them using an app – either on your phone or via the open-source Audible for Linux tool (<https://github.com/cross-platform/audible-for-linux>). This ties you into Audible's DRM system, meaning you won't be able to combine your Audible titles with those sourced elsewhere.

Until recently, there was a free solution to this in the form of OpenAudible – it's now shareware, but if you're desperate to produce non-DRM versions of your Audible books, then the US\$12 registration fee isn't too prohibitive. By way of compensation, it supports up to three separate Audible accounts and comes with a year's worth of updates.

To get started, head over to <https://openaudible.org> to download a DEB package or AppImage – the latter is the simplest to use: simply place it in your Home folder and don't forget to right-click it and choose Properties > Permissions to tick the all-important 'Allow executing file as program' box before launching.

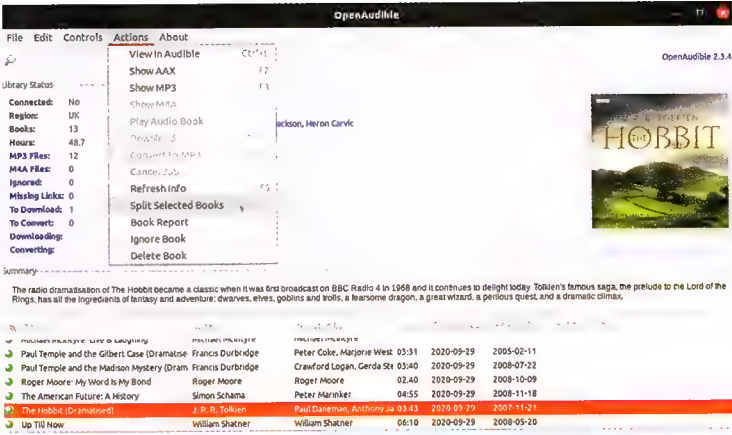
Once up and running, press Ctrl-K to open a browser window that will redirect to audible.com.au – look for the Sign In button in the top right corner to log into your Audible account. Once logged in, close the browser window to return to the main OpenAudible interface. Next, choose Controls > Quick Library Sync and after a short pause you should see your Audible purchases appear.

Next, select a title – you'll see a summary and artwork appear. Its State should read 'Ready to download'. Choose Actions > Download and wait for the audiobook to download in its

OpenAudible converts your Audible purchases into DRM-free audiobooks for your own consumption on your choice of platform.

**QUICK TIP**  
When it comes to assigning genres to your audiobooks, avoid the generic 'Audiobook' to come up with specific book genres like Mystery or Sci-Fi. Search [www.goodreads.com](http://www.goodreads.com) to see how other readers have categorised a book, if necessary.

Ignore tagging your files when ripping in fre:ac – your focus should be on naming them in the correct sequential order.



native AAX format. All of this can be done for free, but this is the point where you'll need that licence. If About > Purchase doesn't work, head to <https://openaudible.org/purchase> to buy through FastSpring. Once you've received your licence code, choose 'About > Activate' to enter it, then press Ctrl-T to convert the file to MP3 format.

One final step: the file is converted into a single file by default, so once done you'll need to choose 'Actions > Split Selected Books' and wait while a progress bar reveals how many chapters or files will be created, plus keep you updated with how it's getting on.

Once all this is complete, a folder window will open to reveal your converted audiobook inside a sub-folder with the title as its name. You can now copy or move this into your Audiobooks library (you'll need to create an Author folder if you've not done so already to place the folder in).

For those with large Audible

libraries, there's some good news: once you've purchased a licence, any book you subsequently download will be automatically converted to MP3 (see Edit > Preferences where you can also adjust the encoding quality of the resulting MP3 file if you wish to change the balance of file size versus audio quality). Select multiple books at once and choose Actions > Download to do so – you'll be prompted about automatic conversion for the first book, but thereafter it'll all proceed in the background. And once that process completes, choose Actions > Split Selected Books to complete the process.

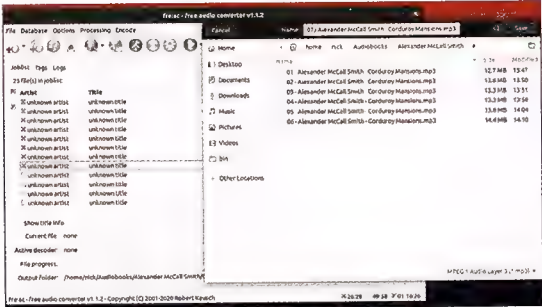
**Rip audiobook CDs**  
When it comes to ripping audiobook CDs, you'll need a ripping tool that can combine multiple tracks into a single file – we recommend fre:ac, which you can install through the Software Centre. To enable this feature in the program, choose Options >

Track down cover art

To hunt down artwork for your audiobook, head to <https://images.google.com.au> and search for the title of your book plus the word 'audiobook'. You'll almost certainly get a match, but wait – is it suitably hi-res? Our preferred size is 600x600 pixels, although 500x500 is the size of artwork embedded into your Audible collection by OpenAudible.

To locate higher res artwork more easily, click Tools under the Google Search button and change Any size to Large, which will filter out smaller images. Hopefully at least one will remain: click it to view a preview. Roll your mouse over this to reveal its size – if large enough, right-click it and choose 'Save image as' to save a copy to your hard drive. Use your image editor to reduce both its physical size to 600x600 if necessary, plus its file size by saving it as a JPEG.

If you're struggling to find a suitably sized image via a keyword search, save the largest version of the artwork you can find, then click the camera icon inside the Google Image Search box and choose 'Upload an image' to search using the actual image itself. If you're lucky, you'll see an 'All sizes' button appear next to the image thumbnail: click this and hopefully it'll reveal a higher resolution image that you can use.





General settings. Verify the LAME MP3 encoder has been selected, then check 'Encode to a single file'. Click Select under Output folder to select your Audiobooks folder and untick 'Use input file folder if possible'. Ignore the 'Filename pattern' field for automatically naming your output files – it doesn't work when ripping multiple tracks to a single file.

Spoken audio recordings take up less space than regular music due to their relative simplicity, but you can squeeze them even smaller by switching from stereo to mono recordings: click Configure encoder next to the LAME MP3 encoder to do so. Change the Use preset to Custom settings, then switch to the Misc tab and choose Mono under Stereo mode before clicking OK.

Next, insert the first disc of your first audiobook and click the 'Add audio CD contents to the joblist' button. You'll see all the CD's tracks appear, accompanied by an error message stating that the freedb.org database has no record of the CD. This will be true for most – if not all – audiobook CDs, so choose Database>Automatic CDDb queries to remove the automatic check.

At this point, you could tag your files using fre:ac's Tags>Albums tab section where you can manually input the author (Artist)



and book title (Album), plus add artwork, a year and genre. While this works perfectly, it's very fiddly – you need to add this information manually each time you insert a new CD, and it's much quicker to handle the process later on using Kid3, so for now leave everything set as 'untitled'.

### Select tracks to rip

Now, you need to select all the tracks you plan to rip as your first file. If you're ripping an entire disc, just make sure everything's selected; otherwise you need to locate the first and last tracks that make up your selection – either aim for 25 (or 35) minutes for an arbitrary break, or use the playback controls above the track list to work out where each chapter begins and ends.

Finally, click Select next to Output folder to open your Audiobooks folder, then manually

You can create your own custom genres in Kid3, enabling you to add another layer of organisation to your audiobooks.

create a new author folder (or select an existing one if applicable) followed by a folder named after the book title. With this selected, you can now click the green 'Start the encoding process' button from the main toolbar.

You'll be prompted to save the file – automatically named Artist – Album (or Author – Book Title). mp3. Be sure to insert a track number at the beginning corresponding to the chapter, part, or disc number – so 01-Author-Book Title.mp3, for example. You might even prefer to name the file 01-Chapter One.mp3 or whatever naming convention you like – just make sure the track number is at the beginning.

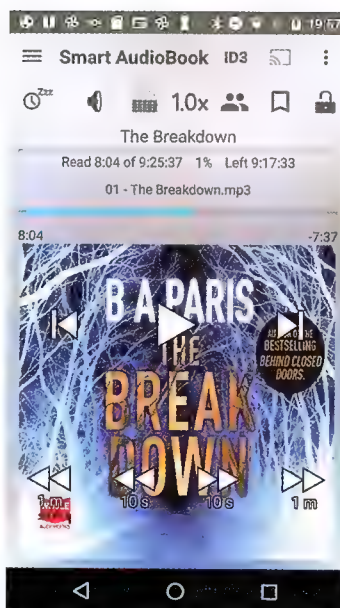
Once you click Save, the rip will begin. A progress indicator will reveal how your rip is progressing and completed tracks will disappear from the queue. When complete, a single MP3 file will have been created. Now repeat the process for the next chapter or part, and when you've finished with a disc, move on to the next.

## Android audiobook heaven

Want to listen to audiobooks on your Android phone? The obvious solution is to install the official Booksonic app (\$4.99), which not only streams books from your server to save space on your phone, but enables you to mark individual titles for listening to offline. This means that they're temporarily downloaded to your phone's storage, which makes it possible for you to listen to them anywhere, then easily removed when you're done.

If all you want is to listen to audiobooks you've transferred to your phone's storage – after all, you can fit a heck of a lot of books on to a 32GB microSD card – then try Smart AudioBook Player instead. When you first launch it, simply point the app towards your Audiobooks folder, then refresh the library to view a complete list of books, sorted by author and then title. Tap one to access its own playback screen where you'll find all the controls you need – and then some, including Characters (to help you remember who's who) and Bookmarks (for jumping to favourite passages quickly).

After 30 days, the app reverts to a basic cut-down version – it has all the core functionality you need, but the full version costs just \$2. Select Help>Features to compare versions followed by Help>Version>Buy to purchase.



Smart AudioBook Player has all the playback controls you could ever need (or want, frankly).

### Tag your media

Once you've ripped your audiobook CD, it's time to tag it using a tagging tool. We've opted for Kid3, which is regularly updated and has evolved into just the tool for audiobook tagging. It's best installed through the Terminal to ensure you get access to the latest version:

```
$ sudo add-apt-repository
ppa:ufleisch/kid3
```

```
$ sudo apt-get update && sudo
apt install kid3-qt
```

Once installed, launch Kid3 and choose Settings > Configure Kid3. Up the 'Track number digits' to 2 (so 01, 02 rather than 1, 2, etc), and tick Album Artist and Composer under Quick Access Frames before dragging and dropping them in alphabetical order. Like Artist, Album Artist will record the author's name, while the Composer field is for recording the audiobook's narrator. You'd expect



things to be the other way round, but go figure...

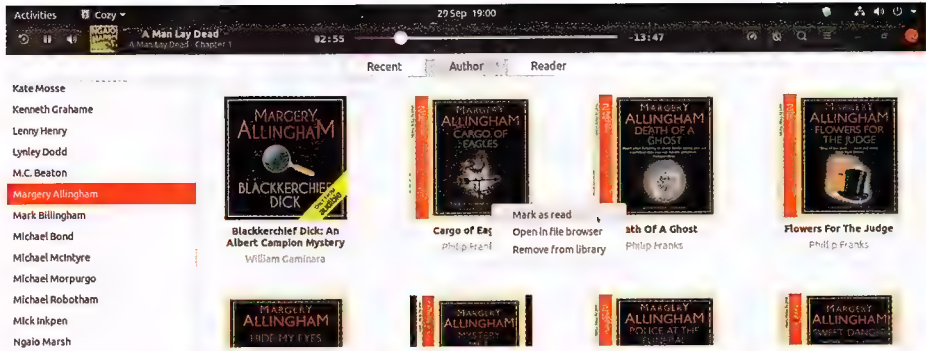
Use the Custom Genres section to input custom audiobook genres – click Add for each one, from Horror and Crime to Sci-Fi and generic Fiction. When you're done, tick 'Show only custom genres' if you want to remove all other auto-suggestions as you fill the Genre tag. Once you've tweaked Kid3's settings to your satisfaction, click OK. You're now ready to tag your files – the step-by-step guide (below) reveals how to apply consistent tags across all your audiobook's files, and add album art.

How to enjoy your audiobooks

Once your audiobooks have been ripped, organised and tagged, it's time to enjoy the fruits of your labours. While you can listen to an audiobook through any music player in Linux, it'll be a messy process trying to combine music and audiobooks within the same program, never mind library. Instead, use a dedicated audiobooks player called Cozy, which you must install through Flatpak:

```
$ sudo apt install flatpak
$ flatpak install flathub com.github.geigi.cozy
$ flatpak run com.github.geigi.cozy
```

The program will launch – going forward, it can be opened through the Launcher. Step one is to import your audiobooks – simply select your Audiobooks folder to proceed and Cozy will import them into its library. Once complete, choose



Dedicated audiobook player Cozy works beautifully with your audiobook library – no need to play them in a music utility.

**QUICK TIP**  
We've chosen MP3 as the file format for our audiobook library because spoken word recordings don't require audiophile levels of quality. When you factor in the length of most audiobooks – many hours per title – the smaller your files the better.

your view: Author displays titles by Composer field (meaning the narrator), while Reader displays them by Album Artist (so the author).

Hang on – haven't we just organised everything the other way around? Yes, because other audiobook programs and services organise them that way, as do regular music players. Don't worry, though, because Cozy can be configured to swap them round to avoid confusion: click its menu button and choose Preferences > Behaviour tab, then flick the 'Swap author and reader' switch to instantly correct the view.

Now return to your chosen view, where you'll be greeted by a two-pane window. On the left is a list of authors or narrators (depending on your view), while the right-hand pane displays a list of titles, again in alphabetical order, complete with artwork. Use the left-hand pane to filter the view by author/narrator if necessary, then roll your mouse over its image cover to reveal a play button to click; alternatively, click elsewhere on the artwork to

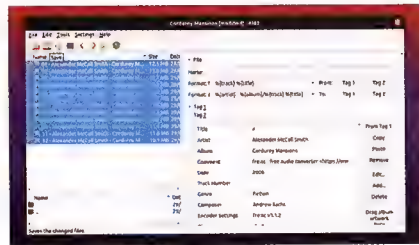
view the title up close.

Cozy's user interface is straightforward to navigate – you'll see a series of buttons across the top, including a handy 30-second rewind button next to the play/pause button, plus a progress bar to navigate quickly through the current track. You'll also find playback speed, sleep timer, and search buttons to the right.

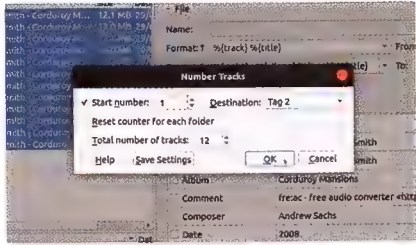
Click the menu button for more options – you can manually refresh the library after ripping new audiobooks, tick the box to hide unavailable books (such as those stored on currently disconnected external or network storage), plus revisit the Preferences section, where you can add additional folders to Cozy's library if you wish via the Storage tab.

And what about consuming your audiobook collection on other devices? The box (opposite) reveals all you need to know about listening to your audiobook collection on your Android phone. ■

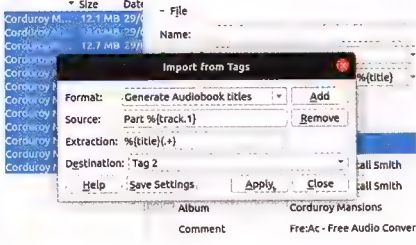
HOW TO Tag your media with Kid3



**01 SET COMMON TAGS**  
Choose File > Open to select all your audiobook's files and click Open – they should appear highlighted in blue. Tick all the tags that will apply to all tracks: Album Artist, Artist, Album, Date, Genre and Composer, and fill in each field. Add your artwork by dragging the file to where it says 'Drag album artwork here'. Click Save to save your changes.



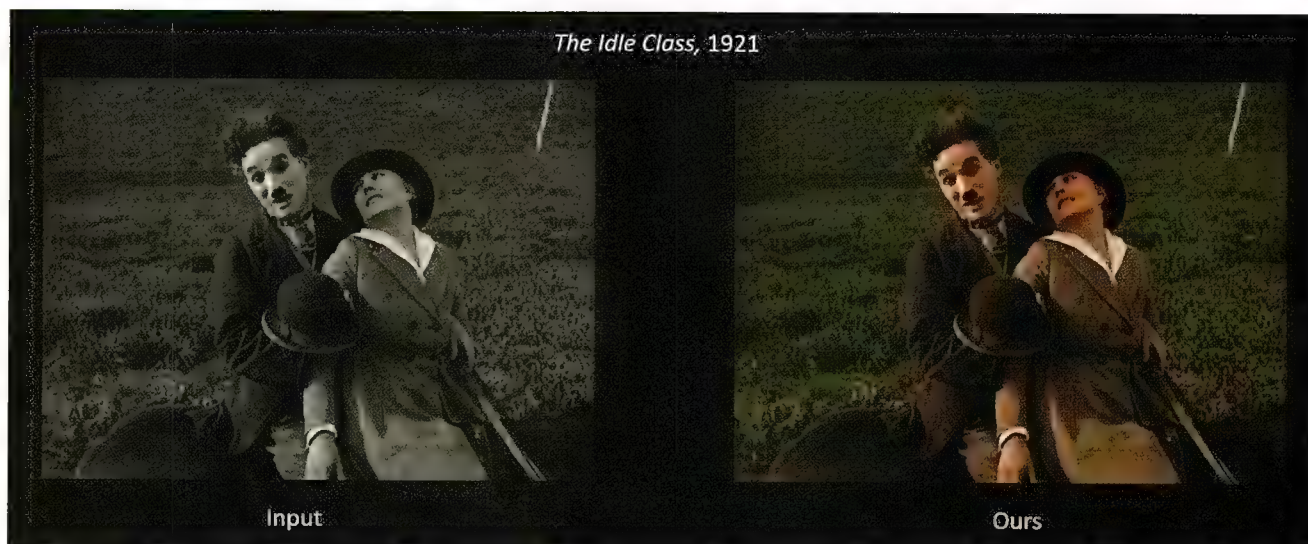
**02 ADD TRACK NUMBER**  
Next, you need to tag each file with its specific track number. To do this, verify all files are still highlighted, then choose Tools > Number Tracks. Make sure the Destination is set to Tag 2, click Save Settings to make this default going forward, and click OK. Select each file in turn to verify the correct track number has been assigned. Click Save again.



**03 ADD TITLE INFORMATION**  
Again, with all the tracks highlighted, choose File > Import from Tags. Click Add, name it Generate Audiobook Titles, and type the following string into the Source box: Part %(track.1) – replace Part with Chapter or Disc as required. Type %(title)(.+) into the Extraction box, and select Tag 2 under Destination. Click Save Settings > Apply, then click Save for the last time.



The Idle Class, 1921



MASTERCLASS

## Colour by numbers: colouring images and video with AI

Machine-learning is turning black-and-white images and videos into vibrant modern-day replicas. Darren Yates shows how to colourise black-and-white photos for free.

Hang around YouTube long enough these days and it won't be long before you run up against videos claiming to be new colourised versions of film shot back at the turn of the 20th century. The videos are often up-scaled to 4K-resolution and with excellent smoothing techniques that your brain says can't be 10 years old, let alone 120. However, it's all the work of new machine learning techniques, one of which is the popular 'Deoldify'. It's not perfect, but can do a pretty decent job. This month, we'll show you how to colourise black-and-white photos for free.

### Machine learning to the rescue!

Artificial Intelligence or 'AI' is the media catch-phrase for all things to do with computers, algorithms and the concept of 'learning'. However, this 'machine learning'

is being applied to areas of knowledge as broad as spam detection to predicting the weather. More recently, it's been applied to image colourisation, through a type of machine-learning known as 'deep learning'.

Remember back at school when you had to study for a maths exam? You'd study practice problems (and look at the answers), so that when you hit the exam, you'd know how to answer the real questions. Image colourisation works in a similar same way. A machine-learning algorithm is fed thousands of image pairs – one colour, the other black-and-white and both of the same image. Think of this as the black-and-white image being the 'problem' and the colour version as the 'answer'. The algorithm learns how the pair images relate and creates a set of rules or 'model' that explains this relationship. However, the new model can also

Above: The colourisation technique featured in this video was developed by the Hong Kong University of Science and Technology (see [youtu.be/Y15uv2jnK-4](https://youtu.be/Y15uv2jnK-4)).

be used to predict the colourised version of a previously-unseen black-and-white photo – a bit like a question in an exam. There are any number of ways to build a model, but one recent effort making waves is called 'Deoldify'. It's being used to create those YouTube videos, but is also available for you to colourise monochrome images for free via an online learning toolkit.

### How to use it

While Deoldify is a machine-learning library you can download and install on your PC and code with the Python programming language, like many complex machine-learning models, it needs plenty of horsepower (or at least a half-decent video card).

Alternatively, if you have a paid-up account with the family-history website, MyHeritage, you can get colourising that away.

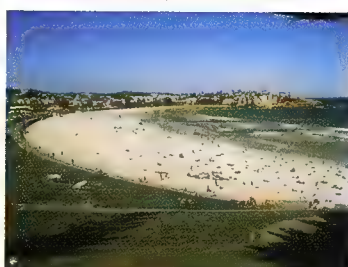
However, there is a third option. It's free and features in Google's CoLab on-line coding tool. Head to [tinyurl.com/colourise-apc489](https://tinyurl.com/colourise-apc489) and follow these steps:

- 01 Click on the Connect command (top-right of window) and 'Connect to hosted runtime'.
- 02 Follow each step. Where you see a pair of square brackets '[ ]', roll your mouse over it and it'll become a play button. Press to run that command and do each

ORIGINAL COLOUR IMAGE



COLOURISED/DEOLDIFY IMAGE



A CoLab/Deoldify colourisation of Bondi Beach (image source: Wikipedia).



- one in sequence.
- When you reach the 'Instructions' section, read through the basics there.
  - At the 'Colorize!!' section, enter in the URL of the image you want to colour. This CoLab notebook requires your images be accessible online with a unique URL. Next, set the `render_factor` (lower gives more colour but less positional accuracy) and the 'watermark' option.
  - Roll your mouse over the brackets directly under the 'Colorize!!' heading and click. After a minute or so, depending on the image size, the results will appear on screen. You can also use colour source images – these will be converted to B&W and then colourised.

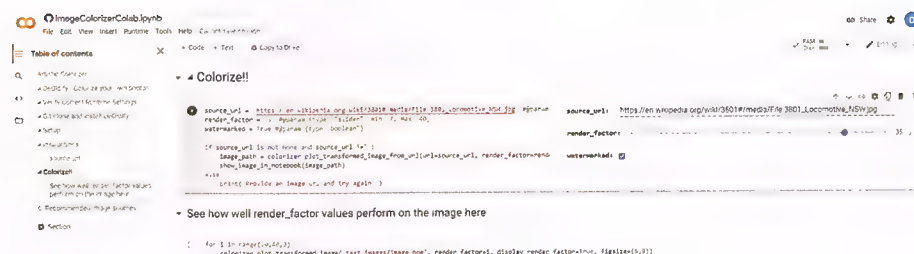
## The results

Give Deoldify portrait photos or landscapes and the results are quite impressive. You can use the `render_factor` slider to adjust the level and positional accuracy of the colourisation. By definition, monochrome images have no colour information, so the fact the Deoldify model can produce such realistic results shows the power of machine learning.

## However...

Deoldify doesn't always get it right. The thing you have to remember about machine-learning (and why the 'artificial intelligence' moniker is a misnomer) is that it only recognises image types it's seen before. Landscape? Yep. People? No worries. Australian steam locomotive 3801? Not so fast. New South Wales' iconic war-time steam loco is recognised around the world, but not by Deoldify. We fed in monochrome and colour source images of 3801 and while it colourised the surrounding landscape, it left the loco itself as a lifeless wartime-grey rather than the vibrant yellow-lined green it has carried for much of the last 60 years and still has today.

By training with thousands of images, the Deoldify model builds up a knowledge base that allows it to make predictions on how images should appear. The problem is that if the model is given an image type to colourise that it can't recognise – in this instance, steam loco 3801 – it doesn't know how to respond. The grey is a result of converting the



When you get to 'Colorize!!', enter the image URL and press the tiny circular play button.

colour image to monochrome before colourising it.

This shouldn't really be a surprise, though. Since machine-learning is modelled on the way humans learn, you can't expect a model to recognise an image type it hasn't seen before. Note, we're not saying 'an image' it hasn't seen before, but an image type. Deoldify doesn't need to have seen every image in existence to recognise sky, trees, people for example – by training the model, it recognises what trees, sky and people look like. However, more specific objects like trains and planes can be trickier unless the model has been trained to see them.

## Many images = video

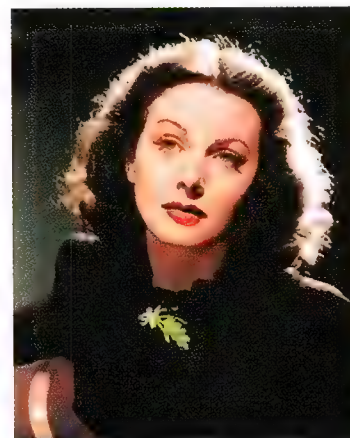
String multiple images together and you end up with video. Video data streams are arguably more complex to deal with but there are some excellent examples of different colourisation models that the machine-learning community is churning out, with numerous

examples on YouTube (try <https://youtu.be/Y15uv2jnK-4> for just how good video colourisation can look). When you consider the first attempts at colourisation required hand-painting individual frames, you can understand why this literal new 'colour-by-numbers' technique is so popular.

## Give it a go

The one caveat with this CoLab notebook is that we don't deal with privacy and security, so we recommend you stick to publicly-available photos, unless you're ready to research Deoldify for your own needs. Nevertheless, Deoldify actually does a pretty decent job of what it does understand, which seems to be general landscapes and people-portraits. There is something evocative about black-and-white film and images that I hope we never lose, but if you want to imagine what those old images might look like in colour, Deoldify is a great place to start. ■

The CoLab/Deoldify's before-and-after shots of actor and inventor Hedy Lemarr.



ORIGINAL COLOUR IMAGE

COLOURISED/DEOLDIFY IMAGE

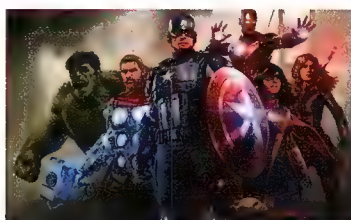


The CoLab/Deoldify model didn't recognise NSW steam loco 3801, leaving it grey.



# DOWNTIME

SHAUN PRESCOTT WITH ALL THE NEWS IN THE GAME.



## Marvel's Avengers fails to win hearts and minds

It seemed like a no-brainer: a blockbuster *Marvel's Avengers* game featuring playable versions of each key Avenger, with a substantial single player component and a long-in-the-tail game-as-a-service model. But it looks like *Marvel's Avengers* hasn't done particularly well for Square Enix, following the game's launch in September. In addition to the not-quite-scientific matter of declining player counts on Steam (they don't take into account console engagement, for example), Square Enix company president Yosuke Matsuda indicated during a recent investor Q&A that COVID-19 is partially to blame.

"In addition to the amortisation of [*Marvel's Avengers*] development costs, another significant factor associated with the title was the fact that we undertook a major advertising campaign at the time of its launch to make up for delays in our marketing efforts resulting from the COVID-19 pandemic," Matsuda said.



## Hyrule Warriors: Age of Calamity sells three million copies worldwide in just four days

The impressive sales figure comes from an official press release from developer Koei Tecmo on Famitsu. *Hyrule Warriors: Age of Calamity* is the first game in the *Warriors* franchise to exceed three million copies sold worldwide, which makes it the most successful game in the series so far. It's all the more noteworthy when you consider it sold so many copies just a handful of days after its release.



GAMING NEWS

## H1Z1 and Everquest studio has a new owner

Daybreak goes to Stockholm.

It's been a turbulent five years for the studio responsible for *Everquest*, *Planetside 2* and *H1Z1*. Between 1997 and 2015, Sony Online Entertainment developed a stable of highly-regarded multiplayer games, before the studio decamped from Sony to become Daybreak Game Company. Since then, the California institution has been plagued with lay-offs, as well as the decline in popularity of once thriving titles like *H1Z1*.

But hopefully the situation will change

with the recent announcement that Swedish "global gaming cooperative" Enad Global 7 has acquired the studio. The latter recently acquired *MechWarrior* studio Piranha Games.

"Together we have bold and exciting plans for the future, and I look forward to making those dreams a reality for gamers all over the world," EG7 CEO Robin Flodin said of the acquisition.

## Microsoft Flight Simulator gets VR support

The update is free, and all headsets are supported.

*Microsoft Flight Simulator* seems like the perfect game for virtual reality, and it's something fans have been begging for since the game's announcement. So it's welcome news that following a closed beta in October, VR support for *Microsoft Flight Simulator* now has VR support, as of December 22.

Not only that, but if you've got any kind of VR headset you'll be good to go: there's no exclusivity. "The Oculus family, the Valve family, every family of headset are going to be supported," executive producer Martial

Bossard said in a recent stream. The update is free, and unlike the feature's alpha period, you'll be able to use menus with your headset on.

The free VR update was initially meant to release alongside the HP Reverb G2, which has been available since November.

The December 22 implementation comes ahead of the sim's next big content update, which will add up to 60 new points of interest to Great Britain, including new airports, Manchester Barton and Land's End. That's scheduled to launch January 28.





## Hades is the god-like winner of Critic's Choice at the Golden Joystick Awards 2020

Supergiant Games takes the title with its deadly dungeon crawler.

*Hades*, the stylish dungeon crawler from Supergiant Games, has been named as this year's winner of the Critic's Choice category in the Golden Joystick Awards 2020.

A beautiful and brutal tour through the Greek underworld, the game has found a legion of fans who can't get enough of its fast-paced action, mythical weapons, and its cast of beguiling characters. Plus the fact you can of course pet Cerberus, Guardian of the Underworld, who is a very good boy.

You play as Zagreus, son of Hades,

desperate to escape his deathly home and make it to Mount Olympus. Enemies and hazards stand in his way, but gods like Zeus will drop in to lend a helping hand in the form of buffs. You won't succeed on your first try, but every run will be different, and each attempt will give you the chance to unlock new Olympian boosts and weapons to make your next run the one that really counts. It almost makes dying horribly at the hands of monsters feel fun. You can play the game now on PC and Nintendo Switch.

## Phil Spencer teases Xbox TV app plans

"I think you're going to see that in the next 12 months."

Your next Xbox may be your TV. Xbox boss Phil Spencer talked about the recent launch of Xbox Series X and Xbox Series S in an interview with *The Verge*, and he also discussed what the platform's future looks like as streaming games from the cloud becomes more and more common. In fact, you're likely to see a dedicated Xbox app start popping up on smart TVs much sooner than later.

"I think you're going to see that in the next 12 months. I don't think anything is

going to stop us from doing that," Spencer said.

Executives don't just throw out teases like that for no reason. Spencer is stopping just short of outright confirming that Microsoft is working on an Xbox app for Smart TVs. The company has probably already reached out to smart TV manufacturers such as LG, Samsung, and Vizio about getting the app on their respective TV operating systems if he's willing to tease that coming within the next year.



## War Thunder gets a brand new engine and prettier graphics in its big 'New Power' update

*War Thunder* got its long-awaited 'New Power' update last month, updating the game's engine and vastly improving its graphics in the process. According to the update notes, the skies will look prettier and more realistic, as will bullet contact, explosions and fire. Aircraft destruction has been revamped as well.

Most of the graphical buffs focus on realism: ground vehicles will now have more realistic shell hits, destroyed ground vehicles now look even more on fire (both inside and out). A key new gameplay mechanic is that the "shape of the penetration now depends on the angle of impact" when missiles hit ground vehicles.

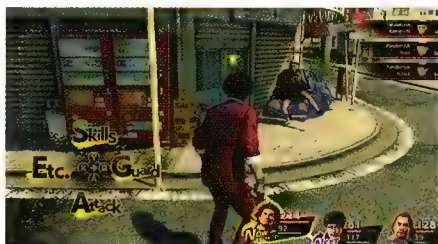
There are new war machines involved as well, with 15 new aircraft, 14 new tank models, as well as battleships and aircraft carriers.



## Nintendo Game & Watch latest platform to run *Doom*

Since the release of the limited edition device, viewers of YouTuber 'stacksmashing', who hacks and dismantles consoles online, have been asking him if it can play *Doom*. Stacksmashing's latest video demonstrates how he was able to hack the Nintendo Game & Watch in order to port *Doom*: "It's not yet performing great, I had to remove a lot of textures, sound had to be disabled, the screen resolution is slightly reduced, and there's still a lot to do before you can enjoy the full game." ■





\$89.95 | PC, PS4, PS5 | [likeadragon.sega.com](https://likeadragon.sega.com)

# Yakuza: Like a Dragon

Doubles down on the series' RPG elements with a brave new turn-based battle system.

Playing a *Yakuza* game without series stalwart Kazuma Kiryu in the leading role takes some getting used to. But luckily for *Yakuza: Like a Dragon*, it's easy to warm to new hero Ichiban Kasuga. He has all the strength and determination of his predecessor, but with a goofy sense of humour and an endearing enthusiasm for everything he does – whether that's taking on the Korean mafia or employing a chicken to run a sweet shop.

Ichiban starts out as a low-level yakuza in Kamurocho, the Tokyo red light district that serves as the main setting for most of the *Yakuza* games. But after a series of unfortunate events, he ends up homeless in Yokohama. *Yakuza: Like a Dragon* is about Ichi getting his life back together, reckoning with his past, and beating a lot of people up along the way.

In many ways, this is classic *Yakuza*. It features an immersive, detailed urban Japanese setting filled with minigames, absurd sidequests and karaoke bars. The story is an unlikely mix of criminal

conspiracy, heartfelt melodrama and slapstick comedy. And when a problem arises, it's usually solved with outlandish violence.

However, when it comes to the combat, this is anything but a typical *Yakuza* game. The usual combo-based brawling has been replaced by a new turn-based battle system. It's pretty standard JRPG fare, with buffs, debuffs, status effects, and a mix of weapon-based and magic attacks. The vibrant presentation, superb animation and lively pace make up for its simplicity, but selecting things from a menu does lack the satisfying brutality and immediacy of a standard real-time *Yakuza* fight.

The problem is, there's far too much fighting. Yokohama isn't as dense or storied as Kamurocho, despite being several times its size, but the developer's knack for evocatively capturing the mundane details of everyday life in Japan is as strong as ever. I just wish I could enjoy the place at my own pace without running into large groups of enemies every 30 seconds.

In previous *Yakuza* games you'd frequently get stopped on the street by thugs looking for a fight, but the battles were over pretty quickly and seamlessly. Here, the endless transitioning in and out of turn-based battles really ruins the flow of exploration.

You feel like you're being interrupted, rather than these encounters being an organic part of the world. And the sheer volume of battles means the novelty of your party's ludicrous special abilities soon wears thin, which in turn makes the combat incredibly repetitive.

This is one of the most uneven *Yakuza* games in the series. A lot of the time you can't help but get swept up by its eccentric charm. Then, at other times, you're praying for the battles to end as you traipse through another series of corridors.

ANDY KELLY

A fun, charming, and occasionally brilliant *Yakuza* game, let down by an overabundance of turn-based battles.

★★★★☆





\$84.95 | PC, PS4/5, XB1, XBX/S | dirtgame.com

# Dirt 5

Ventures down a well-travelled track.

What is *Dirt 5* for? I don't know the answer, and I'm not sure Codemasters does either. The problem, is that recently *Dirt Rally* and its sequel came along. It was so brilliant it reminded us how much we missed pace-notes, and realistic offroad handling. Just like that, we like the old style of rally game again. The one *Dirt* was invented to revitalise. Which leaves game number 5 without a clear raison d'être. All the core elements, its essential *Dirt*-osity, were devised as a deliberate departure from sim-minded, realistic driving. But right now, as *Dirt Rally 2* enjoys a passionate community and sim-racing esports gain momentum, sim-minded, realistic driving is exactly where the excitement is.

Of course, you might really fancy a non-taxing racer, where braking is genuinely optional and a familiar pyramid of events wraps itself around you from the career menu like a comfort blanket. We all fancy that sometimes, and *Dirt 5* is those things, certainly – it's just a very familiar version of those things. The handling model doesn't want to step out at the back and have you wrestling to find balance. It

wants to comply. You can toss most vehicles into most corners with a quick lift of the throttle and emerge more or less on the pace.

From structure to track design to presentation to handling, it's all exactly what you expect to find in a *Dirt* game, delivered without surprises or noticeable steps forward. Surprises aren't in abundance on the track either. There's a lot of fireworks and confetti and pyrotechnics going off as you hit a jump, but AI drivers don't mix it with you or with each other as they would in a *GRID* game.

*Dirt 5* isn't a bad game, just tired and dulled through time and little change. Instead of jettisoning its identity it's playing too safe, holding onto it too closely in search of the apocryphal casual racing gamer who's scared of brake pedals.

PHIL IWANIUK

Offers up some arcade offroad racing of the sort we've played four times previously.

★★★★☆



Free | PC, Mac, Linux [dustyroom.itch.io/empty](https://dustyroom.itch.io/empty)

# Empty

How to disappear completely in minimalist puzzle game.

*Empty* is a game about stuff, more specifically getting rid of it, as you Marie Kondo your way around a sequence of rooms, ridding the colourful 3D spaces of all their clutter.

But *Empty* is a puzzle game. Rather than dragging the unwanted items into a skip, you have to vanish them instead, by lining each up against a surface of the same colour. Turn the scene so that the orange lamp is facing the orange wall, and the lamp will disappear, while the wall will turn white so that it can't be used again. Oh fantastic, you think, the lamp's no longer blocking the green desk, so let's rotate the room until that lines up with the green ceiling. You see how it goes: you vanish each item in turn until all the marked items are absent, and the room looks like it's never been lived in.

The puzzling is satisfying and relaxing, and without being a massive hassle like a real clear-out would be.

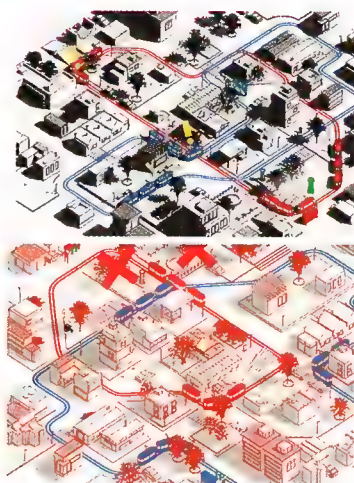
TOM SYKES

More could have been done with the idea, but *Empty* is still a lovely puzzler.

★★★★☆







Free | PC, Mac, Linux | [dustyrroom.itch.io/sparvagn](https://dustyrroom.itch.io/sparvagn)

## Spårvagn

How (not) to run a tram line.

In each cityscape, you have to manage a couple of tram lines long enough for all the waiting passengers to be collected. The trams move automatically, but you can pause them momentarily by clicking on them – and if you don't, a collision will occur sooner or later. However, leave them paused too long and they might be bashed from behind by another tram running on the same line. And that makes all sorts of mess.

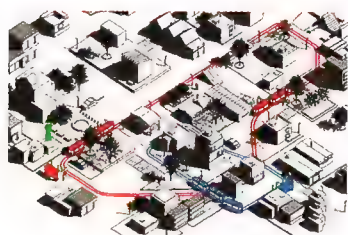
There are red tracks, featuring red trams, and blue tracks featuring blue ones, with the different colours operating at different speeds. Multiple trams soon appear on each criss-crossing track, but you can only halt one of each colour at a time, giving you another thing to have to worry about – it's a little hectic.

This is a game of chain reactions, as all your tactical pauses – even the briefest ones – come back to haunt you. Make just one tiny catastrophic collision and you'll have to replay the entire stage.

TOM SYKES

*Spårvagn is a delightful game that knows it's frustrating.*

★★★★☆



\$43 | PC, XB1, XBX/S | [thefalconeer.com](https://thefalconeer.com)

## The Falconeer

Talon stories of good vs eagle.

*The Falconeer* takes place in a unique world that sits somewhere outside our own, a world that slowly drew me in as I progressed through the story. A huge expanse of water littered with islands controlled by warring factions, the tale that this place tells is interesting enough to prevent you from skipping through the NPC chatter that precedes each mission.

As a falconeer, you'll dive to increase speed and flap in place to reduce it, stretching your falcon's wings out to turn when necessary. The accompanying squawks, flaps, and screeches work in tandem with the wonderful animation to give a convincing sense of being in control of a bird. Or at least, a small/normal sized person on top of one.

While the shooting would feel at home in a WWII dogfighting game, it feels perfectly natural here. Although activities broadly fall into one of three categories (attack, defence, delivery), I never found myself getting bored of them. *The Falconeer* is a joy to control no matter what you're doing, and not just because you're rather amusingly given a barrel roll evasion move. Once combat makes its inevitable appearance,

it's a pleasing aerial dance between me and, usually, just a few enemies before we continue on our way.

However, there are no checkpoints, and this is a big issue for these missions. If I die partway through, I need to start all over again. I then find myself circling the ship in agitation, impatiently awaiting a fight that I know is coming while the ship merrily chugs along at what is now a frustratingly slow pace.

Difficulty throughout the story is all over the place, with no smooth gradient. Significant difficulty spikes are rare, but very annoying when they hit, to the point where I eventually kicked the difficulty down to Easy to soften (but not negate) their effect.

Despite these criticisms – and despite the absence of the option to automatically target a chasing enemy – the game still, mostly, shines.

LUKE KEMP

*Despite a little turbulence, *The Falconeer* takes you on a memorable ride as you swoop through the sky.*

★★★★☆





\$38 | PC, PS4/5, Mac | bugsnax.com

# Bugsnax

Hanging out with a cast of grumpuses.

Grumpuses love turning into bugsnax. And they aren't shrieking monsters. They're regular people, albeit bean-like and snaggletoothed. They're cute, actually, and when they aren't becoming snack foods, they even edge past wackiness and sentimentality and slice into human experience. I didn't care for the actual bugsnax catching in *Bugsnax*, but working through the grumpuses' insecurities was sweet – like a sweetiefly or a sprinklepede, perhaps.

As you may have guessed, the bugsnax are literally bug-like snacks: grapeskeetos, pineantulas, sandopedes, and so on. You play as a nameless journalist who has been summoned to investigate these bugsnax by their discoverer. Except, when you arrive at Lizbert's island, she and her partner Eggabell are both missing, and the settlement they established is in ruins. The grumpuses who followed them there have scattered to the island's conveniently distinct biomes to do their own things – all except hapless mayor Filbo, who enlists your help to reunite the town and find Lizbert and Eggabell.

Over the course of seven-to-ten hours, you'll locate the scattered

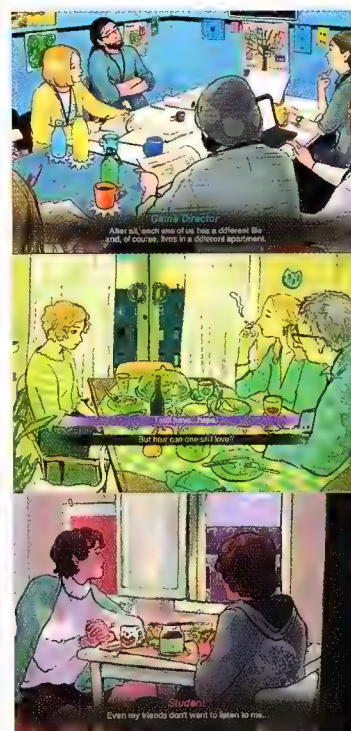
townsfolk in a forest glade, on the beach, among desert mesas, in an alpine forest, and on the peak of a volcanic mountain. Of course, none of them will come back to town straight away: you have to capture and feed them certain bugsnax to help them fulfil their objectives first. You don't have to catch all that many bugsnax. Following the main quests, you only need to trap whatever bugsnax the grumpuses ask you to feed them. I didn't bother much with optional snack, because the characters are the highlight of *Bugsnax*, not the hunting.

I wish *Bugsnax* was more fun, but its cheerful grampus body horror did change me, ever so slightly, and the price is fair for its weird, grisly story (at the end, it might be a bit dark for little kids). I suspect it's better shared with someone who can laugh with you than played alone at a monitor, having your sense of self eroded by the repetition of the words "weeny, weenyworm".

TYLER WILDE

A weird little story with loveable characters, but the actual bug hunting isn't all that much fun.

★★★★☆



Free | PC, Mac, Linux | bit.ly/35XL5hL

# Beyond Your Window

Be a nosy neighbour.

This asks you to imagine the world on the other side of that pane of glass. What's going on in the lives of your neighbours? By clicking on four apartment windows, in any order you desire, you'll witness glimpses of their lives, as they struggle with relationships and work-life balance.

You'll drop in on each twice before witnessing the resolution, which takes the form of direct interviews with the cast and seemingly a few of the (real) developers of *Beyond Your Window*. It's an unusual ending, and I enjoyed how it leant against the fourth wall, coolly smoking a cigarette, but it didn't seem to change based on the few decisions I had made throughout the stories. You'll influence some quite a lot – by getting a woman back with her ex, for example – and others only a little.

I really enjoyed the glimpses. The comic book-style art is gritty and beautiful, and there's a great sense of atmosphere, as you view the outside of the building before diving in to see what's going on inside.

TOM SYKES ■

Not enough of it to cohere into a satisfying story, let alone four.

★★★★☆









DEVELOPER RELIC ENTERTAINMENT PUBLISHER THQ RELEASED SEPTEMBER 20, 2004 WEB [bit.ly/36COuEG](http://bit.ly/36COuEG)

# Warhammer 40,000: Dawn of War

The real king of the RTS genre, according to Steven Messner.

It's a tragedy that *Warcraft III* got an HD remaster – albeit a half-arsed one – but if I want to play *Warhammer 40,000: Dawn of War* I need to download widescreen hacks and an app just to remap the controls and get it into a playable state. Blizzard's seminal RTS no doubt deserves all the praise it gets, but all these years later *Dawn of War* feels like the strategy game that really pushed the genre into new and interesting spaces. It's not just the glorious, violent battles that erupt constantly across each mission, but the way *Dawn of War* cleverly trims the fat to create a strategy game that feels innovative and exciting even 16 years later.

I didn't appreciate that the first time I played it, though. For most of my life, I had chugged

Blizzard's kool-aid and assumed Warhammer was a cheap knock-off for grown men who like gluing things together and spending \$40 on tiny vials of paint with ridiculous names like Runelord Brass. But if you read last month's Game Changer, you'll know that James and I both recently decided to read some *Warhammer 40k* novels for the first time and instantly became converts. That naturally meant I had no choice but to consume all Warhammer media I could possibly find, and with *Dawn of War* and its expansions sitting in my Steam library, it was a natural place to start. I just wanted something to tickle my fancy for this new universe I suddenly developed an appetite for – but I didn't expect this to rocket to the top of my favourite RTS games.



*"I didn't expect this to rocket to the top of my favourite RTS games."*

## Rip and tear

First released back in 2004, *Dawn of War* follows a chapter of Space Marines called the Blood Ravens as they work to delay an Ork 'WAAAGH!' (40k parlance for 'unstoppable invasion') while the last human inhabitants of Tartarus regroup and flee the planet. Once Chaos Marines and Eldar start getting involved, though, the whole operation goes sideways as ancient demonic artefacts whisper betrayal and an impending warpstorm – basically an evil space hurricane – threatens to trap everyone on a planet overrun by Orks and demons.

That *Dawn of War*'s story manages to be this interesting decades later is a testament to how fun it is despite being so thoroughly incapable of nuance. Like many of the novels, its plot twists are seen coming miles away, but I don't care because I'm





too enchanted by the stoicism of the Blood Ravens captain, Gabriel Angelos, and his too-wise-for-his-own-good Librarian Isador. A lot of it is buoyed by the voice acting, though, which manages to somehow bring a bit of life to a group of super-soldiers who are only capable of feeling either righteous indignation or anger.

You don't play *Dawn of War* for the story, though. You play it to gleefully watch a crab-like Chaos Marine Defiler wade into a group of Space Marines, pluck one up with its enormous mechanical claw, and toss his crumpled body half-way across the map. I feel like it's moments like this that are missing from other RTS games of that era, especially *Warcraft III*. There's almost a kind of disregard for the spectacle of watching giant fantasy armies clash in battle. Units just hit each other with the same attack animations until one dies.

*Dawn of War* relishes in the violence. Every unit has bespoke 'sync kills' that trigger when they deal the killing blow against an enemy. When the Eldar summon the Avatar of Khaine in the

seventh mission of the base campaign, much of the reason it's so terrifying is not just because it takes half an army to kill. It's terrifying because again and again it'll impale Space Marines on its sword and hoist them upward so that gravity slowly pulls them further down onto the sword amid gouts of blood. Often I'm so caught up with zooming in and rotating the camera to watch the carnage that I forget to feed my units new orders. I just want to soak it all in.

It's a system that only works because *Dawn of War* uses a unique squad system where individual units are actually composed of up to nine soldiers who act in unison. It's such a great deviation from the standard RTS formula where a single soldier represents a single unit, not only because it adds some significant layers of strategy – like being able to purchase weapon upgrades for individual members of a unit or reinforce your damaged units with fresh recruits – but because it also adds a lot more meat to the grinder.



## Expanded universe

*Dawn of War's* three expansions, ranked.



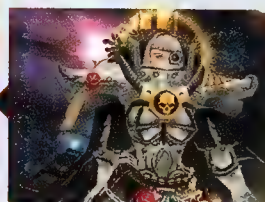
### DARK CRUSADE 2006

Adds an incredible sandbox campaign mode with RPG elements and two new races: the techy Tau and the creepy robot Necrons.



### WINTER ASSAULT

Tough-as-nails campaign where you often swap between two different armies mid-mission, tons of new units, and a cool new faction.



### SOULSTORM 2008

Too ambitious for its own good, but still added two unique factions and aerial combat. You could probably just skip over it, though.





That's not the only innovation that makes *Dawn of War* still relevant today, however. It also disposes with the resource collection systems that I've come to despise in games like *StarCraft* only because it's so fiddly. It's not fun having to constantly micromanage whether or not my worker units are accessing the right resources back at base instead of pushing deeper into the map and watching fights break out.

### Taking control

Instead, resources are earned by spreading out and grabbing control points. Even by today's standards, it's such a genius evolution because it directly ties combat to your overall wealth and economy – especially in multiplayer where players are actively working to defeat one another. There's no option to just turtle up inside your base and wait for players to come to you because you'll also be starving yourself. You have to be aggressive.

Obviously that kind of



playstyle makes perfect sense in the Warhammer universe. Hell, even the opening cinematic for *Dawn of War* shows an entire squad of Blood Ravens getting decimated by Orks while trying to take a control point seconds before an army of Space Marines arrives to save the day. They could've just hunkered down and waited, but that's not the Space Marine way. That kind of wanton disregard for the individual sacrifice so long as it translates to increased control of the map infuses *Dawn of War* with a brutality you just don't see in other similar RTS games.

It's just a shame that Relic hasn't found a way to update the base game to run better on modern hardware. While the second expansion, *Dark Crusade*, introduces support for more wide aspect ratios, *Dawn of War* can only handle 1920x1440, which creates borders on the left and right of the screen and noticeably cuts down on how much you can see on the map. There's a widescreen fix but it warps the size of the minimap so that it no longer fits within its borders,

effectively cutting off pieces of it from your view.

I can deal with that, though, but it's enormously frustrating that you can't even bind certain keys. I didn't even know that there was a pause button until a friend mentioned it, but it's bound to the Pause key, which I don't have on my smaller keyboard. My only option was to download a program called AutoHotKey, which can rebind keys at a system level.

It's why I wish *Dawn of War* could get a remaster of its own. The ideas and systems holding this game together feel as subversive and exciting today as they probably did back in 2004. And even though the graphics aren't great, it doesn't take anything away from the thrill of *Dawn of War*'s bloody battles. It's just a shame that a few technical issues can make returning to Tartarus a little annoying. Even so, it's easy to look past those moments when you're wrapped up in the intensity of a skirmish or playing through the surprisingly good story campaign. ■



## CHIP CHAT

JOEL BURGESS REPORTS ON THE UNUSUAL SIDE OF TECH NEWS



IGIS Report to OAIC on COVID app data – 16 May to 16 November 2020

## Summary

The Office of the Inspector-General of Intelligence and Security (IGIS) has worked with agencies within IGIS jurisdiction to ensure that they are aware of their obligations under the *Privacy Act 1988* in respect of COVID app data. We have also been briefed on technical capabilities and have reviewed the policies and procedures that have been implemented by relevant intelligence agencies in the event that collection of COVID app data occurs.

As at 16 November 2020, the acting Inspector-General is satisfied that the relevant agencies have policies and procedures in place and are taking reasonable steps to avoid intentional collection of COVID app data. Incidental collection in the course of the lawful collection of other data has occurred (and is permitted by the Privacy Act); however, there is no evidence that any agency within IGIS jurisdiction has decrypted, accessed or used any COVID app data.

Inspection activities are planned in coming months to verify data deletion and to provide further assurance that no COVID app data has been accessed, used or disclosed.

## ASIO 'incidentally' collecting COVID Safe app location data

Intelligence agencies don't seem to have used the data yet.

The Office of the Inspector-General of Intelligence and Security (IGIS) published a report in November stating that ASIO has been "incidentally" collecting data from the government's COVID Safe app, alongside other personal information. The report notes that although agencies have downloaded COVID app data, there is no evidence to suggest that any of this information has been decrypted, accessed or used in any way. The collection seems to have occurred alongside the broad collection of data under specific warrants, which is permitted by the Privacy Act and the IGIS has deemed that the agencies under its jurisdiction have sufficient policies in place to avoid intentional collection of COVID Safe data.



## Solomon Islands bans Facebook

Restrictions intended to curb social misuse and potential government criticism.

The government of the Solomon Islands is planning to temporarily ban the use of Facebook in the region in order to curb bullying and online defamation, according to Prime Minister Manasseh Sogavare. The ban is yet to be fully detailed, but many international users calling home are expected to be affected by the shutdown. Political opposition leaders are opposing the move stating that the reasons for it were not significant enough. Local anti-corruption groups believe the real motivation for the ban comes after it faced criticism over documents leaked on Facebook in November that detailed how it had used COVID 19 relief funds.



## Baltimore school latest victim of major ransomware attack

Just six months after hackers shut down the Baltimore City Government with a ransomware attack that lasted months and was estimated to have cost the city US\$18.2 million, the Baltimore County Public School has had to suspend classes after its networks were compromised. The school's Chief of Staff Mychael Dickerson tweeted that the school was suffering from a ransomware attack and that the school's technology team was working to address the situation. The hack seems to have affected email and grading systems on the school's Windows-based devices, while its Chromebooks remained unaffected.



## QAnon starters accused of financial motives

4Chan 'moderators' BaruchtheScribe (Paul Furber) and Pamphlet Anon (Coleman Rogers) were responsible for initially plucking the 'Q' posts from a series of anonymously posted conspiracy theories and pushing them to a wider audience through fringe right-wing YouTuber Tracy Diaz. While Diaz's 90,000 subscriber base and eight-million-strong view count across various videos posted on Liberty Movement Radio is almost entirely thanks to being one of the early propagators of Q's theories it seems Rogers is also profiting from the movement. Rogers and his wife run Patriots Soapbox, a QAnon Discord channel that takes PayPal, Bitcoin and cash donations from supporters. There have also been a few slip ups reported by NBC News that suggest Rogers may be posting as Q. ■



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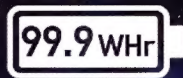
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